

ภาคผนวกที่ 7

เอกสารการสอบเทียบความถูกต้องของเครื่องมือ

Sartorius (Thailand) Co., Ltd.

129 Rama 9 Road, Huaykwang, Huaykwang, Bangkok 10310

Tel: +66 2643 8361-6, e-mail: service.thailand@sartorius.com

**SARTORIUS**

Certificate

of Calibration

Model Number : BP210D
Description : Semi-micro Balance
Serial Number : 70406076
Manufacturer : Sartorius

Certificate No. : 22BNA0225
Issued Date : Thursday, November 10, 2022
Reference No. : 196389
Page No. : 1 of 2

Customer Name : Health & Envitech Co.,Ltd.
77/11 Moo 2, Ngamwangwan Rd., Soi 5, T.Bangkhen, A.Muang, Nonthaburi 11000

Calibrated Place : Health & Envitech Co.,Ltd.
Weighing Room

Calibrated By : Mr.Nathapol Aeimjangpun
Calibration Date : Tuesday, November 08, 2022

Calibration
Procedure No. : This calibration was conducted by
Using in-house calibration procedure number (WI-003)
Based on UKAS LAB 14 :2019

Metrological data :

Capacity : 60/210 g Readability : 0.01/0.1 mg

Ambients Conditions:

Temperature : 25.8 °C ± 5.0 °C
Humidity : 40.2 % RH ± 10.0 % RH
Pressure : — ± —

Reasons for calibration

☐ New Installation ☐ Service / Repaired ☒ Re-calibration/ Maintenance

Equipment Condition: ☒ Good Operate ☐ Fair

Measurement Method UKAS Publication Ref :Lab 14

The measurement uncertainty stated is the expended uncertainty which is obtained from the standard uncertainty multiplied by the coverage factor ($k=2$) to provide a level of confidence of approximately 95%. It is determined in accordance with the Guide to Expression of Uncertainty in Measurement (GUM). The calibration certificate documents the traceability to National Standards, which realise the unit of measurement according to the International Standard System of Units (SI). Report of Tolerance came form list of Sartorius Metrological Specifications.

Traceability:

Model Number	Description	Traceability	Certificate No.	Due Date
YCS011-612-00	Sartorius weight set 1mg - 1kg E2,YCS011-612-00	DKSH	C02222038	29-Sep-2024
608H1	Thermo-Hygrometer , Testo 608-H1	SPC-RT	C19210657	14-Dec-2022

This certificate relate and apply this equipment only.

This certificate may not be reproduced other than in full except with the prior written approval of the Verification Operation Division
Sartorius (Thailand) Co., Ltd.

SOP FM-33 03 February 2022

Mr.Chonchai Inthana (Technical Manager)

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Sartorius (Thailand) Co., Ltd.

129 Rama 9 Road, Huaykwang, Huaykwang, Bangkok 10310

Tel: +66 2643 8361-6 Fax: +66 2643-8367, e-mail: service.thailand@sartorius.com

SARTORIUS

Certificate of Calibration

Model Number : BP210D
Description : Semi-micro Balance
Serial Number : 70406076
Manufacturer : Sartorius

Certificate No. : 22BNA0225
Issued Date : Thursday, November 10, 2022
Reference No. : 196389
Page No. : 2 of 2

Calibration Results : Without Adjustment

Repeatability

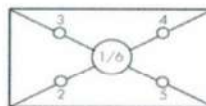
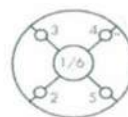
The repeatability is the ability of a weighing instrument to display nearly identical readouts under constant test conditions when the same load within a measurement series is placed repeatedly on the weighing pan in the same manner. The standard deviation is used to express repeatability quantitatively.

Nominal Value : (Low Load)	19.99998	199.9999
20 g	19.99998	200.0000
Tolerance	19.99999	199.9999
0.0001 g	19.99999	199.9999
	19.99998	200.0000
Nominal Value : (High Load)	19.99996	200.0000
200 g	19.99996	199.9999
Tolerance	19.99998	199.9998
0.0001 g	19.99998	199.9999
	19.99998	199.9998
Standard Deviation	0.00001	0.00007

Eccentricity (Off-center loading error)

The off-center loading error is yielded by the difference between the readout of the load, i.e. 1/3 or 1/4 of maximum capacity, placed in the middle of the weighing pan and between each of four additional measurement points (positions defined according to OIML R76).

Nominal value :	100	g
Tolerance	0.0004	g
	Difference	
	1	-
	2	-0.0002
	3	-0.0002
	4	0.0000
	5	-0.0001
	6	-



Linearity

The linearity, also called linearity error. Describes the deviation of the characteristic curve of a weighing instrument from the linear slope.

Tolerance 0.0002 g

Nominal Value (g)	Conventional Mass Value (g)	Displayed Value (g)	Deviation (g)	Uncertainty (g)
0.001	0.00100	0.00100	0.00000	0.00018
0.01	0.01000	0.01001	0.00001	0.00018
0.1	0.10000	0.10000	0.00000	0.00018
1	1.00001	1.00001	0.00000	0.00018
2	2.00001	2.00001	0.00000	0.00018
5	4.99999	5.00000	0.00001	0.00018
10	10.00000	10.00001	0.00001	0.00018
50	49.99999	49.99999	0.00000	0.00019
100	99.9999	100.0000	0.0001	0.00020
200	199.9999	199.9999	0.0000	0.00029



บริษัท เอ็นไวร์ เซอร์วิส จำกัด

บริษัท เอ็นไวร์ เซอร์วิส จำกัด
ENVIR SERVICE CO., LTD.

42 รามอินทรา 14 แยก 9 แขวงท่าแร้ง เขตบางเขน กรุงเทพฯ 10230 โทรศัพท์ 02-9435814-5 โทรสาร 02-9438201
42 Raminthra 14 yeak 9, Tha Rang, Bangkhen, Bangkok 10230 Tel : 02-9435814-5 Fax : 02-9438201

Analyzer Performance Test

Calibrated Date: 01 July 2022

Instruments Information

Analyzer Type: NO/NO2/NOx Analyzer Model: 42C	Manufacturer Thermo Environmental S/N: 42CHL-0527613257
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Calibration System

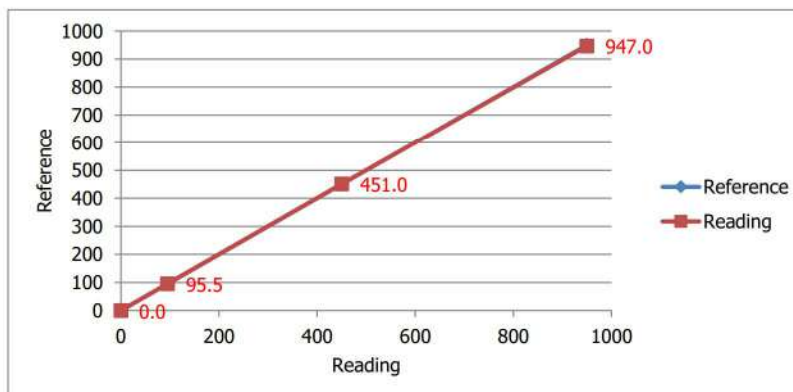
Calibrator Unit	Standard Gas
Dilutor Model Dasibi Model 5008 S/N: 705 ZERO AIR Generator API MODEL 701 S/N: 1924	NO Conc 957.2 PPM SO2 Conc 960.7 PPM CO Conc 960.4 PPM Cylinder Number EB0128898 Expire Date: 29 Oct. 2027

Environment: Temperature 25.5 °C

Humidity: 51 %RH

CALIBRATION RESULTS

POINT NO	CALIBRATION RESULTS			
	Reference	Reading	ERROR	%ERROR
ZERO	0	0.0	0.00	0.00
1	95	95.5	0.50	0.53
2	450	451.0	1.00	0.22
3	950	947.0	-3.00	-0.32
				0.11



Calibrate By :

Mr. PASAGORN SAMOL

Analyzer Performance Test

Calibrated Date: 01 November 2022

Instruments Information

Analyzer Type: NO/NO2/NOx Analyzer Model: 200AU	Manufacturer: API Environmental S/N: 1176
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Calibration System

Calibrator Unit	Standard Gas
Dilutor Model Dasibi Model 5008 S/N: 705 ZERO AIR Generator API Model 701 S/N: 1924	NO Conc 55.54 PPM SO2 Conc 55.01 PPM CO Conc 4,533 PPM Cylinder number EB0129030 Expire Date: Oct. 29, 2027

Environment: Temperature 25.5 °C

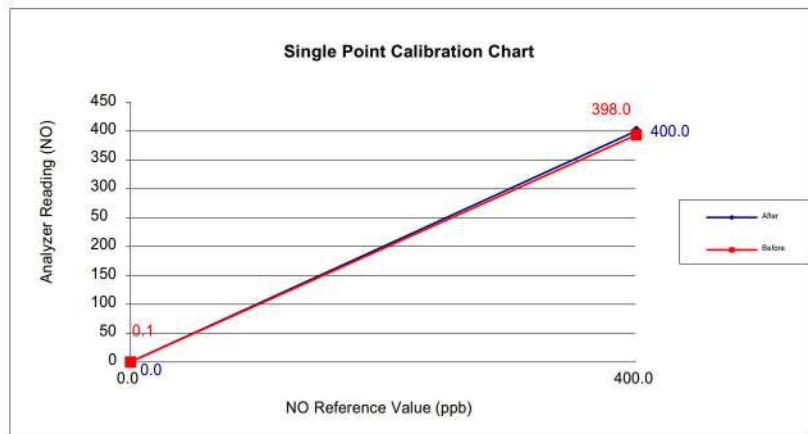
Humidity: 51 %RH

Calibration Check (Before adjust)

GAS	Zero			Span		
	Reading Value (ppb)	Expected Value (ppb)	Drift (ppb)	Reading Value (ppb)	Expected Value (ppb)	Drift%
NO	0.1	0.0	0.1	398.0	400.0	-0.5
NOx	0.1	0.0	0.1	400.0	400.0	0.0

Calibration Check (After adjust)

GAS	Zero			Span		
	Reading Value (ppb)	Expected Value (ppb)	Drift (ppb)	Reading Value (ppb)	Expected Value (ppb)	Drift%
NO	0.0	0.0	0.0	400.0	400.0	0.0
NOx	0.0	0.0	0.0	400.0	400.0	0.0



Analyzer Performance Test

Calibrated Date: 01 November 2022

Instruments Information

Analyzer Type: NO/NO2/NOx Analyzer Model: 200A	Manufacturer API Environmental S/N: 1524
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Calibration System

Calibrator Unit	Standard Gas
Dilutor Model Dasibi Model 5008 S/N: 705 ZERO AIR Generator API Model 701 S/N: 1924	NO Conc 55.54 PPM SO2 Conc 55.01 PPM CO Conc 4,533 PPM Cylinder number EB0129030 Expire Date: Oct. 29, 2027

Environment: Temperature 25.5 °C

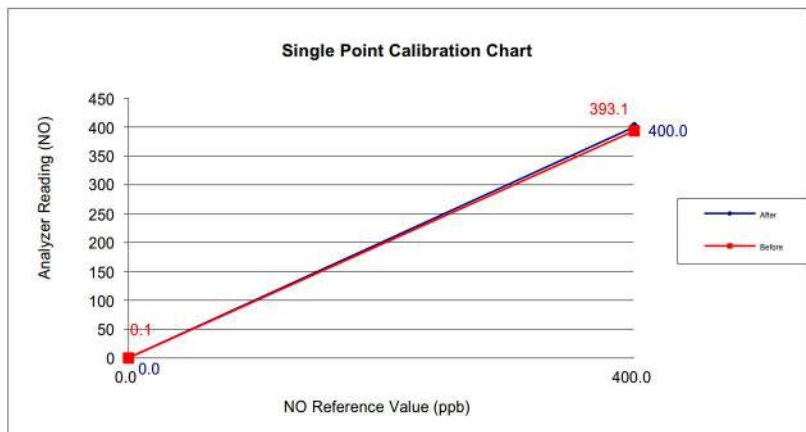
Humidity: 51 %RH

Calibration Check (Before adjust)


GAS	Zero			Span		
	Reading Value (ppb)	Expected Value (ppb)	Drift (ppb)	Reading Value (ppb)	Expected Value (ppb)	Drift%
NO	0.1	0.0	0.1	393.1	400.0	-1.7
NOx	0.1	0.0	0.1	400.0	400.0	0.0

Calibration Check (After adjust)

GAS	Zero			Span		
	Reading Value (ppb)	Expected Value (ppb)	Drift (ppb)	Reading Value (ppb)	Expected Value (ppb)	Drift%
NO	0.0	0.0	0.0	400.0	400.0	0.0
NOx	0.0	0.0	0.0	400.0	400.0	0.0



Approved by :


 Mr. Rung Rittayan

Approved Signatory
(Managing Director)

Analyzer Performance Test

Calibrated Date: 01 November 2022

Instruments Information

Analyzer Type: NO/NO2/NOx Analyzer Model: 200A	Manufacturer: API Environmental S/N: 2364
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Calibration System

Calibrator Unit	Standard Gas
Dilutor Model Dasibi Model 5008 S/N: 705 ZERO AIR Generator API Model 701 S/N: 1924	NO Conc 55.47 PPM SO2 Conc 55.01 PPM CO Conc 4,533 PPM Cylinder number EB0129030 Expire Date: Oct 29, 2027

Environment: Temperature 25.5 °C

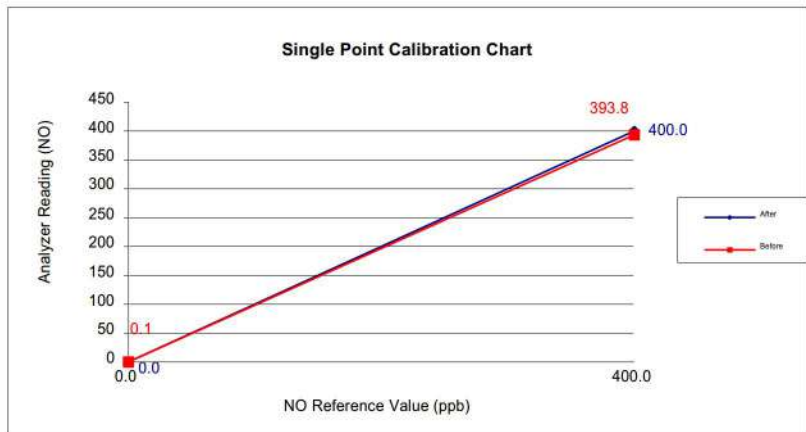
Humidity: 51 %RH

Calibration Check (Before adjust)


GAS	Zero			Span		
	Reading Value (ppb)	Expected Value (ppb)	Drift (ppb)	Reading Value (ppb)	Expected Value (ppb)	Drift%
NO	0.1	0.0	0.1	393.8	400.0	-1.6
NOx	0.1	0.0	0.1	400.0	400.0	0.0

Calibration Check (After adjust)

GAS	Zero			Span		
	Reading Value (ppb)	Expected Value (ppb)	Drift (ppb)	Reading Value (ppb)	Expected Value (ppb)	Drift%
NO	0.0	0.0	0.0	400.0	400.0	0.0
NOx	0.0	0.0	0.0	400.0	400.0	0.0



Approved by :


 Mr. Rung Rittiyan

Approved Signatory
(Managing Director)



บริษัท เอ็นไวร์ เซอร์วิส จำกัด

บริษัท เอ็นไวร์ เซอร์วิส จำกัด
ENVIR SERVICE CO., LTD.

42 รามอินทรา 14 แยก 9 แขวงท่าแร้ง เขตบางเขน กรุงเทพฯ 10230 โทรศัพท์ 02-9435814-5 โทรสาร 02-9438201
42 Raminthra 14 yeak 9, Tha Rang, Bangkhen, Bangkok 10230 Tel : 02-9435814-5 Fax : 02-9438201

Analyzer Performance Test

Calibrated Date: 01 July 2022

Instruments Information

Analyzer Type: SO2 Analyzer Model: 43C	Manufacturer Thermo Environmental S/N: 43CHL-59690-324
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Calibration System

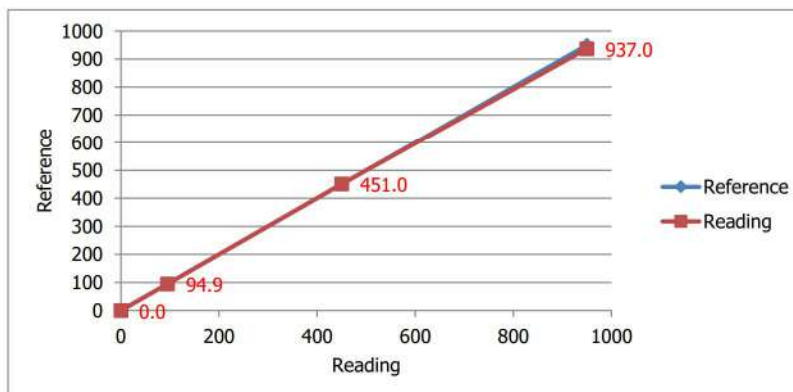
Calibrator Unit	Standard Gas
Dilutor Model Dasibi Model 5008 S/N: 705 ZERO AIR Generator API MODEL 701 S/N: 1924	NO Conc 957.2 PPM SO2 Conc 960.7 PPM CO Conc 960.4 PPM Cylinder Number EB0128898 Expire Date: 29 Oct. 2027

Environment: Temperature 25.5 °C

Humidity: 51 %RH

CALIBRATION RESULTS

POINT NO	CALIBRATION RESULTS			
	Reference	Reading	ERROR	%ERROR
ZERO	0	0.0	0.00	0.00
1	95	94.9	-0.10	-0.11
2	450	451.0	1.00	0.22
3	950	937.0	-13.00	-1.37
				0.31



Calibrate By :

Mr. PASAGORN SAMOL

Analyzer Performance Test

Calibrated Date: 01 November 2022

Instruments Information

Analyzer Type: SO2 Analyzer Model: 100A	Manufacturer API Environmental S/N: 488
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Calibration System

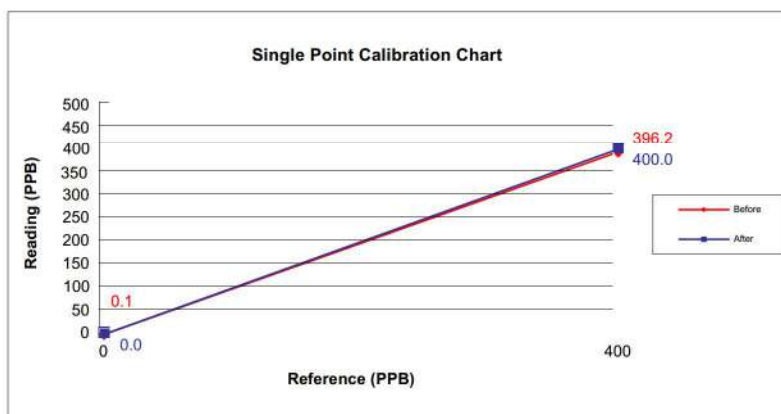
Calibrator Unit	Standard Gas
Dilutor Model Dasibi Model 5008 S/N: 705 ZERO AIR Generator API MODEL 701 S/N: 1924	NO Conc 55.54 PPM SO2 Conc 55.01 PPM CO Conc 4,533 PPM Cylinder number EB0129030 Expire Date: Oct. 29, 2027

Environment: Temperature 25.5 °C

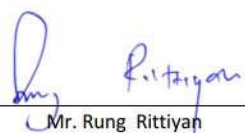
Humidity: 51 %RH

Calibration Report

Status	Zero			Span		
	Reference (PPB)	Reading (PPB)	Drift (PPB)	Reference (PPB)	Reading (PPB)	Drift%
Before	0.0	0.1	0.1	400.0	396.2	-1.0
After	0.0	0.0	0.0	400.0	400.0	0.0



Approved by :


 Mr. Rung Rittiyon

Approved Signatory
(Managing Director)

Analyzer Performance Test

Calibrated Date: 01 November, 2022

Instruments Information

Analyzer Type: SO2 Analyzer Model: 100A	Manufacturer: API Environmental S/N: 1157
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Calibration System

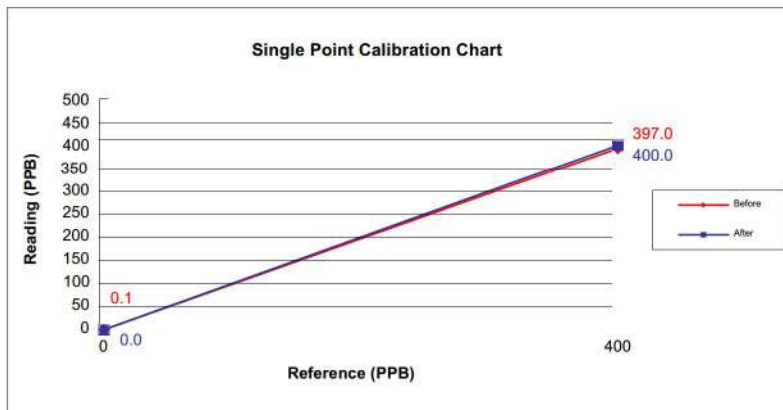
Calibrator Unit	Standard Gas
Dilutor Model: Dasibi Model 5008 S/N: 705 ZERO AIR Generator: API MODEL 701 S/N: 1924	NO Conc: 55.54 PPM SO2 Conc: 55.01 PPM CO Conc: 4,533 PPM Cylinder number: EB0129030 Expire Date: Oct. 29, 2027

Environment: Temperature 25.5 °C

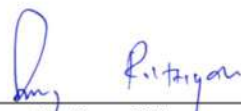
Humidity: 51 %RH

Calibration Report

Status	Zero			Span		
	Reference (PPB)	Reading (PPB)	Drift (PPB)	Reference (PPB)	Reading (PPB)	Drift%
Before	0.0	0.1	0.1	400.0	397.0	-0.8
After	0.0	0.0	0.0	400.0	400.0	0.0



Approved by :


 (Mr. Rung Rittayan)

Approved Signatory
(Managing Director)

Analyzer Performance Test

Calibrated Date: 01 November 2022

Instruments Information

Analyzer Type: SO2 Analyzer Model: 100AS	Manufacturer: API Environmental S/N: 2008
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Calibration System

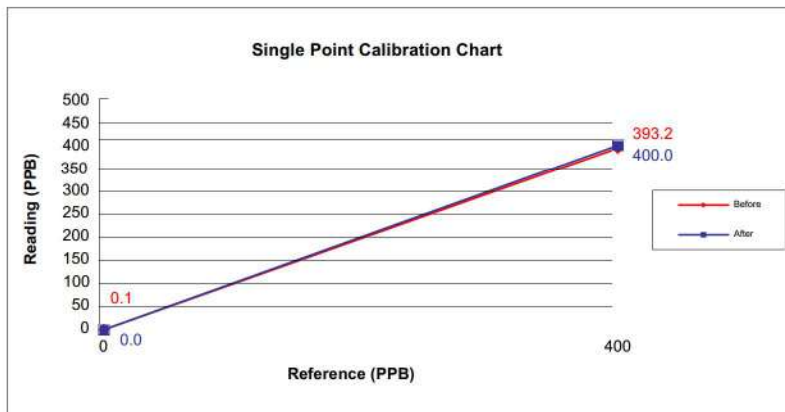
Calibrator Unit	Standard Gas
Dilutor Model: Dasibi Model 5008 S/N: 705 ZERO AIR Generator: API MODEL 701 S/N: 1924	NO Conc: 55.54 PPM SO2 Conc: 55.01 PPM CO Conc: 4,533 PPM Cylinder number: EB0129030 Expire Date: Oct. 29, 2027

Environment: Temperature 25.5 °C

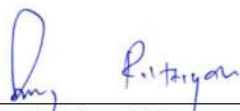
Humidity: 51 %RH

Calibration Report

Status	Zero			Span		
	Reference (PPB)	Reading (PPB)	Drift (PPB)	Reference (PPB)	Reading (PPB)	Drift%
Before	0.0	0.1	0.1	400.0	393.2	-1.7
After	0.0	0.0	0.0	400.0	400.0	0.0



Approved by :


 Mr. Rung Rittiyon

Approved Signatory
(Managing Director)

Certificate of Calibration

Certificate No. : 65-430032-1

Page : 1 of 2

Submitted by : Health & Envitech Co., Ltd.

6 Ngamwongwan Rd., Soi 5, T. Bangkhen, A. Muang, Nonthaburi 11000

Equipment : Digital Conductivity meter with probe

Manufacturer : Eutech

Model : CON 700

Serial No. : 2491409

ID No. : LB-HE-092

Electrode

Model : N/A

Serial No. : CONSEN9501D 226

ID No. : LB-HE-092

Environment : Ambient Temperature $(25 \pm 2) ^\circ \text{C}$

Relative Humidity $(50 \pm 15) \%$

Date of Received : 19 October 2022

Date of Calibration : 22 October 2022

Date of Issue : 22 October 2022

Calibrated by : Bunjerd Masri

Calibration Method : This instrument was calibrated by In-house method direct measurement by conductivity buffer solution

Reference Standard Instruments : This certification is traceable to the International System of Units

Standard Buffer Solution

<u>Material</u>	<u>Lot No.</u>	<u>Exp. Date</u>	<u>Traceability</u>
84 $\mu\text{S/cm}$	5258	01 April 2023	National Institute of Standards and Technology (NIST), U.S.A., S.R
1413 $\mu\text{S/cm}$	6151	01 February 2026	National Institute of Standards and Technology (NIST), U.S.A., S.R
12.88 mS/cm	5764	01 October 2025	National Institute of Standards and Technology (NIST), U.S.A., S.R
111.8 mS/cm	4670	01 October 2024	National Institute of Standards and Technology (NIST), U.S.A., S.R

Approved by :



(Bunjerd Masri)

Supervisor

The Uncertainties are for a confidence probability of approximately 95%

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Certificate of Calibration

Certificate No. : 65-430032-1

Page : 2 of 2

Result of Calibration :

UUC Condition As-Received : Good

Function : Conductivity measurement

Before Adjustment

Standard Conductivity Solution	UUC Reading	Correction	Uncertainty (±)	Unit
84.0	83.3	0.7	1.1	μS/cm
1413	1256	157	5.1	μS/cm
12.88	11.50	1.38	0.051	mS/cm
111.8	88.62	23.18	0.41	mS/cm

After Adjustment : at 84,1413 μS/cm, 12.880, 111.80 mS/cm

Standard Conductivity Solution	UUC Reading	Correction	Uncertainty (±)	Unit
84.0	84.0	0.0	1.1	μS/cm
1413	1413	0	5.0	μS/cm
12.88	12.88	0.00	0.051	mS/cm
111.8	111.8	0.0	0.41	mS/cm

Remark

UUC : Unit Under Calibration

This result of calibration was found accurate as shown on date and place of calibration only.

This reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%

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Instrument information

JANTYTECH
建通科技

Name	WET BULB GLOBE TEMPERATURE (WBGT)METER
Series No	3522210110
Type	JT2011-E2A
Customer	HEALTH & ENVITECH CO., LTD.
Address	6 Ngamwongwan Soi 5, Bangkhen, Mueang Nonthaburi, Nonthaburi 11000

Integrity check of instrument

Appearance	✓
Parts integrity	✓
Screen display or touch	✓
Instrument button	✓
Power supply	✓
battery	✓
Data storage and export	✓
Deviation degree of comparison test with standard instrument	✓

Calibration Results

UUC Sensor	Standard Temperature (°C)	UUC Reading (°C)	Correction (°C)	Uncertainty (± °C)
WET	25.0	24.9	0.1	0.2
	30.0	29.8	0.2	0.2
	35.0	35.1	-0.1	0.2
	40.0	39.8	0.2	0.2
	45.0	44.9	0.1	0.2
DRY	25.0	24.9	0.1	0.2
	30.0	30.1	-0.1	0.2
	35.0	34.8	0.2	0.2
	40.0	40.1	-0.1	0.2
	45.0	45.1	-0.1	0.2
GLOBE	25.0	25.1	-0.1	0.2
	30.0	30.1	-0.1	0.2
	35.0	34.9	0.1	0.2
	40.0	39.8	0.2	0.2
	45.0	44.9	0.1	0.2

Environmental conditions: temperature: 26 °C ± 2 °C, relative humidity: 30% RH ± 10% RH

Reference Standard : Standard Mercury Thermometers, Manufacturer: BGRI, Model: STA, SN : 2-56,

Calibrated Date : 20 February 2023, Calibration Certificate No. : RA21H-AB1000009

This Certificate is traceable to NCMT North China, Certificate No. : RA20J-AK000073

Calibration Engineer : 

Date : March 1, 2023





THAI METEOROLOGICAL DEPARTMENT

4353 Sukhumvit, Bangna, Bangkok 10260 Tel. 081-454-2804, 0-2399-0469

Calibration Certificate

Issued by : Calibration & Test Section : Meteorological Instruments Bureau

Date of Issue 10 February, 2022

Certification No. 043/22

Page : 1 of 2

Object : THERMAL ENVIRONMENT MONITOR

Manufacturer : QUEST TECHNOLOGIES

Type : QUESTEMP[®]32

Serial No. : TPG040022

Customer : Health and Envitech Co.,Ltd.
6 Ngamwongwan Road, Soi 5 Bang Khen,
Muang Nonthaburi, Nonthaburi 11000.

Calibration Condition : Temperature 25.1 °C Barometric Pressure 1009.9 hPa

STANDARD THERMOMETER : Theodor Friedrich : Dry No.8390/94 Wet No. 8389/94

: testo, testo 645 Serial No. 02848057 : Thermoschneider No.6169 , No.6178

: TT-3 Serial 43BE04

Japan Meteorological Agency

Calibrated by :

Mr. Watcharapol Subwat

Mechanical Engineer

Signed :

Mr. Pisood Promsut

(Authorised Signatory)

for the Chief

Sub-Standard Instrument





THAI METEOROLOGICAL DEPARTMENT

4353 Sukhumvit, Bangna, Bangkok 10260 Tel. 081-454-2804, 0-2399-0469

The Result of Calibration

Certification No. 043/22

10 February, 2022

Page : 2 of 2

Standard Temp. °C	Temperature Sensor Reading					
	Dry Bulb °C	Correction °C	Wet Bulb °C	Correction °C	Globe °C	Correction °C
50.12	50.1	0.02	50.1	0.02	50.0	0.12
40.24	40.1	0.14	40.1	0.14	40.0	0.24
30.41	30.4	0.01	30.4	0.01	30.3	0.11
22.24	22.3	-0.06	22.3	-0.06	22.4	-0.16

Calibrated by :

Mr. Watcharapol Subwat

Mechanical Engineer

Calibration & Test Section
Meteorological Instruments Bureau



PM10 HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Sampler Location				Date	October 31, 2022
Project Site				Start Time	2:30 PM
Sampler Number	PM10 No.1056	Transfer Standard Type	Orifice	Stop Time	2:45 PM
Motor Serial Number	PM10 No.1056	Calibrator Model	25A	Person	Mr.Pasagorn Samol
Recorder Serial Number	-	Calibrator Serial Number	307N		

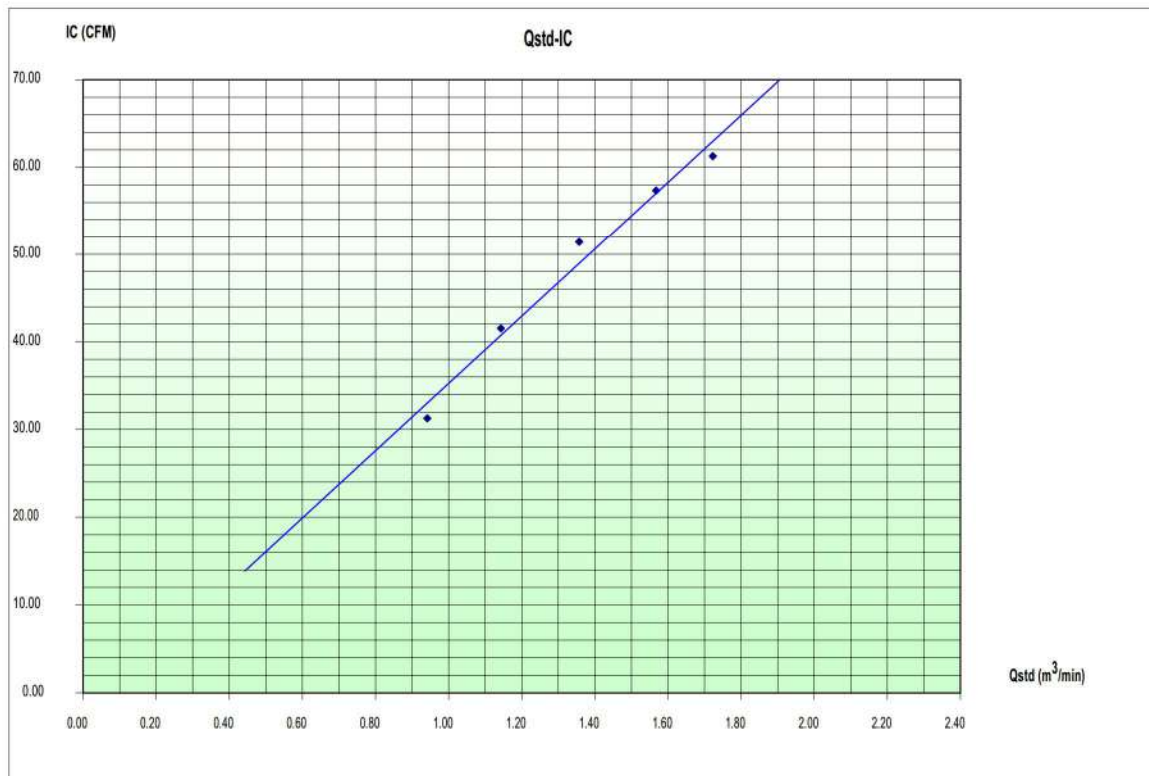
Plate No.	(DeltaH)			(A)	(X)	(I)	(Y)	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Positive	Negative	ΔH_2O	$[\Delta H_2O(Pa/P_{atm})(T_{std}/T_a)]^{1/2}$	$Q_{std} = (1/m)[(A-b)]$ (m ³ /min)	ample Flow Rate Indication (ft ³ /min)	$IC = I[(Pa/P_{atm})(T_{std}/T_a)]^{1/2}$	(°K = °C+273)	(mmHg)		
5	1.9	1.8	3.7	1.91177	0.94446	32.0	31.27	305.0	760.0		
7	2.8	2.7	5.5	2.32610	1.14445	42.0	41.52	305.0	760.0		
10	4.0	3.9	7.9	2.77584	1.36375	52.0	51.40	305.0	760.0		
13	5.3	5.2	10.5	3.20428	1.56798	58.0	57.33	305.0	760.0		
18	6.4	6.3	12.7	3.52396	1.72300	62.0	61.28	305.0	760.0		

Linear Regression Y ON X : Y= mX + b

		Average		Temperature	Barometric Pressure	Start Meter	Stop Meter
1	Slope (m)	2.0635	Linear Equation	r^2	0.982631	Pstd(mmHg)	760.0
2	Intercept(b)	-0.03151	Set Point Flow Rate (X) (m ³ /min)	1.133	r	0.99127746	T _{NTP}
3	Correlation Coefficient (r)	0.99893	Final Set Flow Rate = (I)	0	(Pa/Pstd)*(Tstd/Ta)	0.97704918	
Result				C=(Pa/Pstd)*(Tstd/Ta)*0.5		0.988457981	

COMMENT

Andersen Instruments, Inc.



Calibrated By


Mr.Pasagorn Samol
Technician

PM10 HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Sampler Location				Date	October 31, 2022
Project Site				Start Time	2:00 PM
Sampler Number	PM10 No.1068	Transfer Standard Type	Orifice	Stop Time	2:15 PM
Motor Serial Number	PM10 No.1068	Calibrator Model	25A	Person	Mr.Pasagorn Samol
Recorder Serial Number	-	Calibrator Serial Number	307N		

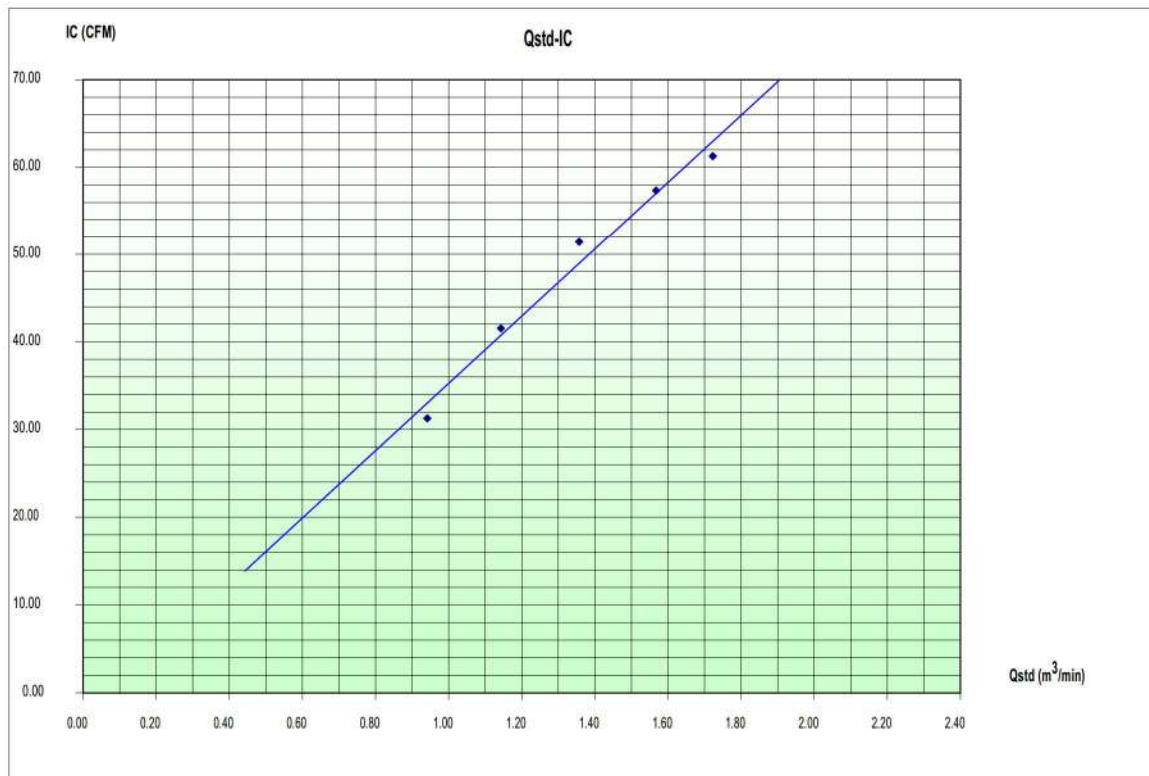
Plate No.	(DeltaH)			(A)	(X)	(I)	(Y)	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Positive	Negative	ΔH_2O	$[\Delta H_2O(Pa/P_{atm})(T_{std}/T_a)]^{1/2}$	$Q_{std} = (1/m)[(A-b)]$ (m ³ /min)	ample Flow Rate Indication (ft ³ /min)	$IC = I[(Pa/P_{atm})(T_{std}/T_a)]^{1/2}$	(°K = °C+273)	(mmHg)		
5	1.9	1.8	3.7	1.91159	0.94164	32.0	31.27	305.0	760.0		
7	2.8	2.7	5.5	2.32655	1.14273	42.0	41.52	305.0	760.0		
10	4.0	3.9	7.9	2.76945	1.35736	52.0	51.40	305.0	760.0		
13	5.3	5.2	10.5	3.20449	1.56819	58.0	57.33	305.0	760.0		
18	6.4	6.3	12.7	3.52396	1.72300	62.0	61.28	305.0	760.0		

Linear Regression Y ON X : Y= mX + b

		Average		Temperature	Barometric Pressure	Start Meter	Stop Meter
1	Slope (m)	2.0635	Linear Equation	r^2	0.982631	Pstd(mmHg)	760.0
2	Intercept(b)	-0.03151	Set Point Flow Rate (X) (m ³ /min)	1.133	r	0.99127746	T _{NTP}
3	Correlation Coefficient (r)	0.99993	Final Set Flow Rate = (I)	0	(Pa/Pstd)*(Tstd/Ta)	0.97704918	
Result	C=(Pa/Pstd)*(Tstd/Ta)*0.5						0.988457981

COMMENT

Andersen Instruments, Inc.



Calibrated By

Mr.Pasagorn Samol
Technician

PM10 HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Sampler Location				Date	November 1, 2022
Project Site				Start Time	10:00 AM
Sampler Number	PM10 No.1070	Transfer Standard Type	Orifice	Stop Time	10:15 AM
Motor Serial Number	PM10 No.1070	Calibrator Model	25A	Person	Mr.Pasagorn Samol
Recorder Serial Number	-	Calibrator Serial Number	307N		

Plate No.	(DeltaH)			(A)	(X)	(I)	(Y)	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Positive	Negative	ΔH_2O	$[\Delta H_2O(Pa/P_{atm})(T_{std}/T_a)]^{1/2}$	$Q_{std} = (1/m)[(A-b)]$ (m ³ /min)	ample Flow Rate Indication (ft ³ /min)	$IC = I[(Pa/P_{atm})(T_{std}/T_a)]^{1/2}$	(°K = °C+273)	(mmHg)		
5	1.9	1.8	3.7	1.90647	0.93916	32.0	31.27	305.0	760.0		
7	2.8	2.7	5.5	2.32235	1.14070	42.0	41.52	305.0	760.0		
10	4.0	3.9	7.9	2.77473	1.35992	52.0	51.40	305.0	760.0		
13	5.3	5.2	10.5	3.20449	1.56819	58.0	57.33	305.0	760.0		
18	6.4	6.3	12.7	3.52396	1.72300	62.0	61.28	305.0	760.0		

Linear Regression Y ON X : Y= mX + b

		Average		Temperature	Barometric Pressure	Start Meter	Stop Meter
1	Slope (m)	2.0635	Linear Equation	r^2	0.982631	Pstd(mmHg)	760.0
2	Intercept(b)	-0.03151	Set Point Flow Rate (X) (m ³ /min)	1.133	r	0.99127746	T _{NTP}
3	Correlation Coefficient (r)	0.99893	Final Set Flow Rate = (I)	0	(Pa/Pstd)*(Tstd/Ta)	0.97704918	
Result				C=(Pa/Pstd)*(Tstd/Ta)*0.5		0.988457981	

COMMENT

Andersen Instruments, Inc.



Calibrated By

Mr.Pasagorn Samol
Technician

TSP HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

Sampler Location				Date	October 31, 2022
Project Site				Start Time	10:00 AM
Sampler Number	TSP No.1055	Transfer Standard Type	Orifice	Stop Time	10:15 AM
Motor Serial Number	TSP No.1055	Calibrator Model	25A	Person	Mr.Pasagorn Samol
Recorder Serial Number	-	Calibrator Serial Number	307N		

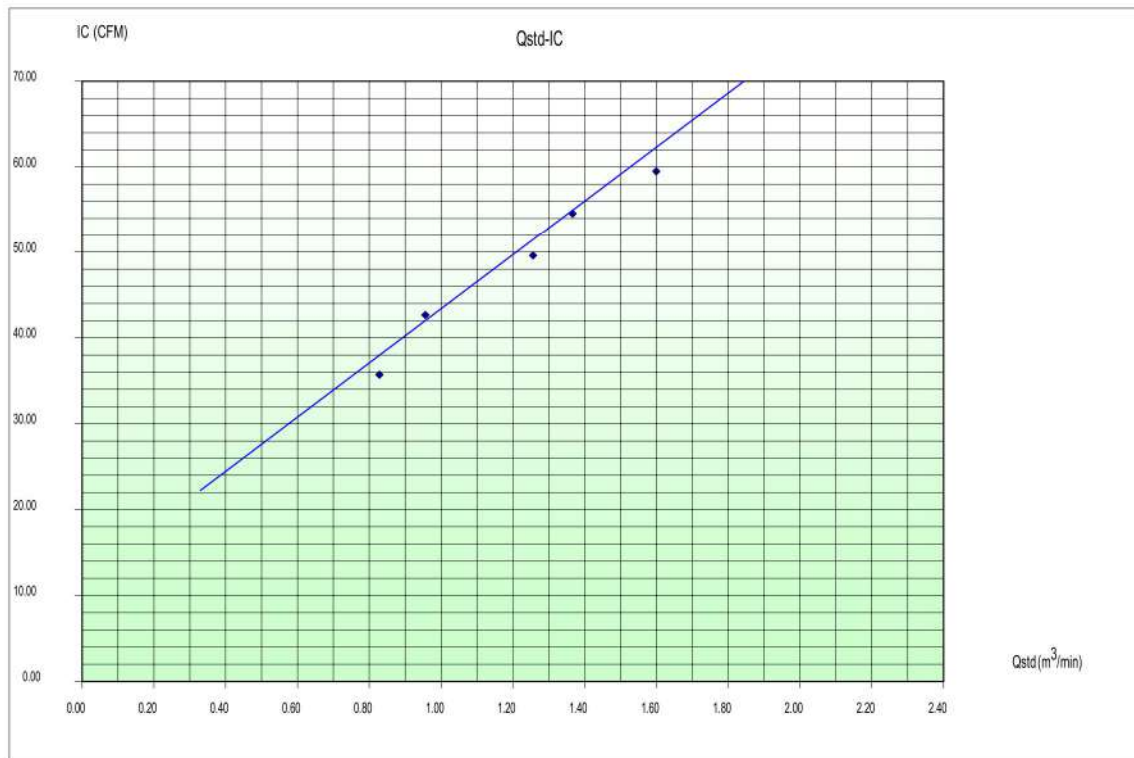
Plate No.	(Delta H)			(A)	(X)	(I)	(Y)	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Pressure Drop Across Orifice (inH ₂ O)			$[\Delta H_2O(PaP_{std})(T_{std}/T_a)]^{1/2}$	$Q_{std} = (1/m)[(A-b)]$ (m ³ /min)	ample Flow Rate Indication (ft ³ /min)	$IC = [(PaP_{std})(T_{std}/T_a)]^{1/2}$	(°K = °C+273)	(mmHg)		
	Positive	Negative	ΔH ₂ O								
5	1.5	1.4	2.9	1.67714	0.82802	36.0	35.70	303.0	760.0		
7	2.0	1.8	3.8	1.94267	0.95766	43.0	42.64	303.0	760.0		
10	3.4	3.3	6.7	2.56124	1.25646	50.0	49.59	303.0	760.0		
13	4.0	3.9	7.9	2.78741	1.36607	55.0	54.54	303.0	760.0		
18	5.5	5.4	10.9	3.26961	1.59976	60.0	59.50	303.0	760.0		

Linear Regression Y ON X : Y= mX + b

1	Slope (m)	2.06353	Linear Equation			Average	303.0	760.0		
2	Intercept (b)	-0.03151	Set Point Flow Rate (X) (m ³ /min)		1.133	r ²	0.999555	Pstd(mmHg)	760.0	
3	Correlation Coefficient (r)	0.99993	Final Set Flow Rate = (I)		0	r	0.999775	T _{NTP}	298.0	
Result							(Pa/Pstd)*(Tstd/Ta)		0.98349835	
							C=(Pa/Pstd)*(Tstd/Ta) ^{0.5}		0.991714853	

COMMENT

Andersen Instruments, Inc.



Calibrated By

Mr. Pasagorn Samol

TSP HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

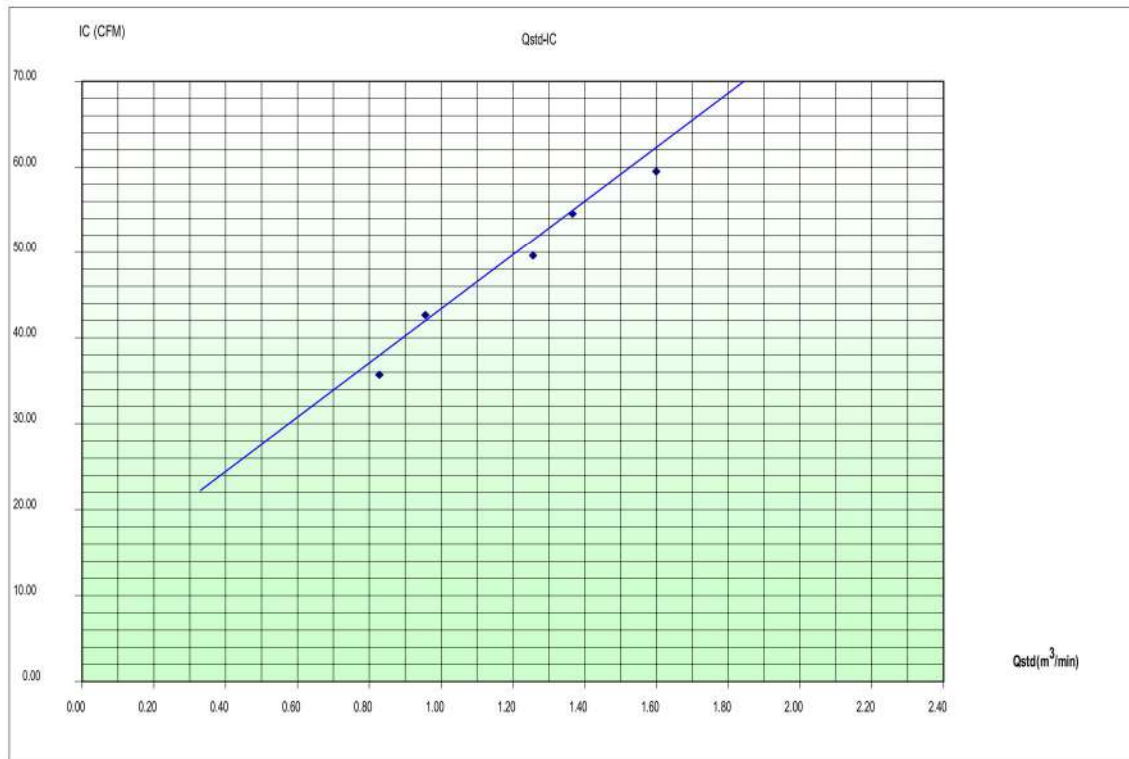
Sampler Location				Date	October 31, 2022
Project Site				Start Time	2:30 PM
Sampler Number	TSP No.1067	Transfer Standard Type	Orifice	Stop Time	2:45 PM
Motor Serial Number	TSP No.1067	Calibrator Model	25A	Person	Mr.Pasagorn Samol
Recorder Serial Number	-	Calibrator Serial Number	307N		

Plate No.	(Delta H)			(A)	(X)	(I)	(Y)	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Positive	Negative	ΔH_{H_2O}	$[\Delta H_{H_2O}(Pa)P_{atm}(T_{ref}/T_a)]^{1/2}$	$Q_{std} = (1/m)[(A-b)]$ (m ³ /min)	sample Flow Rate Indication (ft ³ /min)	$IC = [(Pa)P_{atm}(T_{ref}/T_a)]^{1/2}$	(°K = °C+273)	(mmHg)		
5	1.5	1.4	2.9	1.67714	0.82802	36.0	35.70	303.0	760.0		
7	2.0	1.8	3.8	1.94082	0.95581	43.0	42.64	303.0	760.0		
10	3.4	3.3	6.7	2.56124	1.25646	50.0	49.59	303.0	760.0		
13	4.0	3.9	7.9	2.78741	1.36607	55.0	54.54	303.0	760.0		
18	5.5	5.4	10.9	3.26965	1.59976	60.0	59.50	303.0	760.0		

Linear Regression Y ON X : Y= mX + b							Average	303.0	760.0		
1	Slope (m)	2.06353	Linear Equation				r^2	0.999555	Pstd(mmHg)	760.0	
2	Intercept (b)	-0.03151	Set Point Flow Rate (X) (m ³ /min)			1.133	r	0.999775	T _{NTP}	298.0	
3	Correlation Coefficient (r)	0.99993	Final Set Flow Rate = (I)			0		(PaPstd)(Tstd/Ta)	0.98349835		
Result								C=(PaPstd)(Tstd/Ta)*0.5	0.991714853		

COMMENT

Andersen Instruments, Inc.



Calibrated By

Mr. Pasagorn Samol

TSP HIGH VOLUME AIR SAMPLER CALIBRATION REPORT

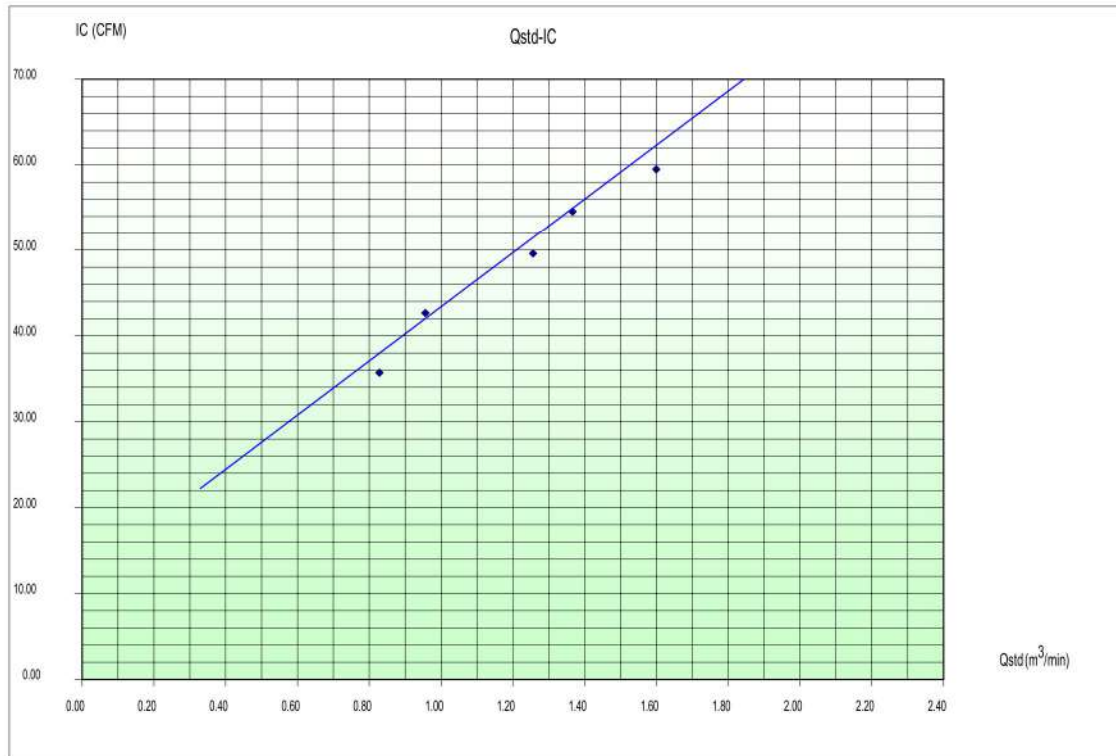
Sampler Location				Date	November 1, 2022
Project Site				Start Time	10:30 AM
Sampler Number	TSP No.1069	Transfer Standard Type	Orifice	Stop Time	10:45 AM
Motor Serial Number	TSP No.1069	Calibrator Model	25A	Person	Mr.Pasagorn Samol
Recorder Serial Number	-	Calibrator Serial Number	307N		

Plate No.	(Delta H)			(A)	(X)	(I)	(Y)	Temperature	Barometric Pressure	Start Meter	Stop Meter
	Positive	Negative	ΔH_2O	$[\Delta H_2O(PaP_{std})(T_{std}/T_a)]^{1/2}$	$Q_{std} = (1/m)[(A-b)]$ (m^3/min)	ample Flow Rate Indication (ft^3/min)	$IC = [(PaP_{std})(T_{std}/T_a)]^{1/2}$	($^{\circ}K = ^{\circ}C+273$) ($mmHg$)			
5	1.5	1.4	2.9	1.67421	0.82660	36.0	35.70	303.0	760.0		
7	2.0	1.8	3.8	1.94336	0.95703	43.0	42.64	303.0	760.0		
10	3.4	3.3	6.7	2.56124	1.25646	50.0	49.59	303.0	760.0		
13	4.0	3.9	7.9	2.78917	1.36692	55.0	54.54	303.0	760.0		
18	5.5	5.4	10.9	3.26965	1.59979	60.0	59.50	303.0	760.0		
Linear Regression Y ON X : $Y = mX + b$								Average	303.0	760.0	

1	Slope (m)	2.06353	Linear Equation			r^2	0.999555	Pstd(mmHg)	760.0
2	Intercept (b)	-0.03151	Set Point Flow Rate (X) (m^3/min)		1.133	r	0.999775	T _{NTP}	298.0
3	Correlation Coefficient (r)	0.99993	Final Set Flow Rate = (I)		0		(Pa/Pstd)*(Tstd/Ta)	0.98349835	
Result							$C = (Pa/Pstd)/(Tstd/Ta)^{0.5}$	0.991714853	

COMMENT

Andersen Instruments, Inc.



Calibrated By

Mr. Pasagorn Samol

**Inctech Metrological Center Co.Ltd.**

39/1 Soi 82, Sukhapiban 5 Rd., O ngoen,

Saimai, Bangkok 10220, Thailand

Tel. (662) 909-8820 (Auto 10 lines) www.imcinstrument.comCalibration Cert. # 3884.01
ISO/IEC 17025

Certificate of Calibration

Certificate No. : MT22-6000

Page : 1 of 2

Customer : Health & Envitech Co.,Ltd.

Address : 77/11 M.2 Ngamwongwan Rd., Soi 5, T.Bangkheng, A.Muang Nontaburi 11000

Description : Hot Air Oven

Manufacturer : Memmert

Model : UNB400

Serial No. : C410.0346

Identification No. : LB-HE-030

Calibration Place : Laboratory 2

Order No. : 3167/22

Received date : Nov 01, 2022

Calibration date : Nov 01, 2022

Environment Condition :

Temperature : (25+/-10) °C

Humidity : (50+/-30) %RH

Calibration Method : Calibration were conducted using In-house calibration procedure *CP-MT-006* According to comparison with LXI Data Acquisition Switch Unit with sensor. The calibration methods based on Euramet Calibration Guide No.20 - guidelines on the Calibration of Temperature and/or Humidity Controlled Enclosures.

Reference Standard Instruments :

<u>Instrument</u>	<u>Model</u>	<u>Serial No.</u>	<u>Certificate No.</u>	<u>Due Date</u>
LXI Data Acquisition Switch Unit with Sensor	34972A	MY49028922	MT21-6790	Nov 25, 2022

This result of calibration was found accurate as shown on date and place of calibration only.

Traceability : This measurement are traceable to the International System of Unit (SI), through National Institute of Metrology Thailand (NIMT)

The reported uncertainty of measurement was based on standard uncertainty multiplied by coverage factor $k = 2$, providing a level of confidence of not less than 95%



Calibrated by : Mr.Arnuparp Sangsrikham

Issue date : Nov 04, 2022

Approved by :

(Mr.Panuwat Phuklan)

This calibration certificate shall not be reproduced other than in full except with the prior written approval of Inctech Metrological Center Co.,Ltd

**Inctech Metrological Center Co.Ltd.**

39/1 Soi 82, Sukhapiban 5 Rd., O ngoen,

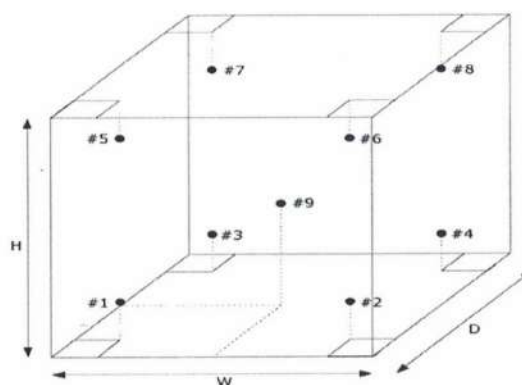
Saimai, Bangkok 10220, Thailand

Tel. (662) 909-8820 (Auto 10 lines) www.imcinstrument.com

Calibration Cert. # 3884.01
ISO/IEC 17025**Certificate No.** : MT22-6000**Page** : 2 of 2**Function** : Temperature measurement**Result** : Without adjustment**Calibration point** : 104, 150, 180 °C**Resolution** : 0.5 °C

Calibration point (°C)	Temperature of UUC* at each position (°C)									Uncertainty of measurement (+/- °C)
	Ch.1	Ch.2	Ch.3	Ch.4	Ch.5	Ch.6	Ch.7	Ch.8	Ch.9	
104	103.575	103.640	103.599	103.733	103.749	103.876	103.928	103.965	104.220	0.49
150	149.590	149.851	149.906	149.846	149.924	149.835	149.983	150.198	150.042	0.45
180	179.608	179.845	179.863	179.864	179.951	179.917	180.096	180.175	180.151	0.46

Setting temperature (°C)	Indicating Temperature (°C)	Measured stability (+/- °C)	Measured uniformity (°C)	Overall variation (°C)
104.0	104.0	0.24	1.1	1.2
150.0	150.0	0.23	0.81	1.1
180.0	180.0	0.23	0.90	1.1



- #1 Lower Left Front
- #2 Lower Right Front
- #3 Lower Left Rear
- #4 Lower Right Rear
- #5 Upper Left Front
- #6 Upper Right Front
- #7 Upper Left Rear
- #8 Upper Right Rear
- #9 Geometric Center

Front view**UUC*** = Unit under calibration**Uniformity** = Maximum and Minimum difference of measured temperature at any probes and the measured temperature at the reference and same time.**Overall Variation** = Difference of temperature value between the maximum and minimum any time.**Stability** = One half of the maximum difference of measured temperatures at any one probe.

-oOo-

Maintenance Protocol

PlasmaQuant PQ 9000 (Elite)

ICP-OES



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1 Customer and service data

Customer address

Company	บ.เฮลท์ แอนด์ เอ็นไวเทค จำกัด
Department	QC
Address (street, number, zip code, city)	6 ซอยงามวงศ์วาน 5 ต.บางเขน อ.เมือง จ.นนทบุรี 11000
Phone	
E-mail	
Customer number	
Order number	

Device data (model and serial number)

ICP OES	PQ9000
Mobile cooling unit	PolyScience
Autosampler	-

Analytik Jena representative information

Name	Mr.Pukitja somton
Company	Analytik-Jena Fareast Thailand

Maintenance date

Date	11/10/2022
------	------------

2 Maintenance with subsequent Operational Qualification (OQ)

- If an Operational Qualification (OQ) is carried out after maintenance, there is no need to check analytical parameters in the maintenance report.
- The analytical parameters are then checked in the separate OQ report.

	Yes	No
Maintenance with subsequent Operational Qualification (OQ)	<input type="checkbox"/>	<input checked="" type="checkbox"/>

3 Maintenance work on the base unit

Update firmware and software

		Complies	Does not comply
Save device parameters and neon table		<input checked="" type="checkbox"/>	<input type="checkbox"/>
Check the firmware version and FPGA		<input checked="" type="checkbox"/>	<input type="checkbox"/>
Check the version of the ASpect PQ software		<input checked="" type="checkbox"/>	<input type="checkbox"/>
Update software, FPGA and firmware		<input checked="" type="checkbox"/>	<input type="checkbox"/>
Approval for firmware and software updates was given by the customer.			
The customer's was informed that the Operational Qualification (OQ) and software validation may have to be repeated for validated systems after a firmware/software update.		<input checked="" type="checkbox"/>	<input type="checkbox"/>
Update ASpect PQ		<input checked="" type="checkbox"/>	<input type="checkbox"/>
▪ Current version	1.2.3.0		
▪ Version after update	—		
Update FPGA		<input checked="" type="checkbox"/>	<input type="checkbox"/>
▪ Current version	h09; h00		
▪ Version after update	—		
Updating the firmware		<input checked="" type="checkbox"/>	<input type="checkbox"/>
▪ Current version	1.36		
▪ Version after update	—		
Record running time (in hours)		<input checked="" type="checkbox"/>	<input type="checkbox"/>
▪ Base unit	3031		
▪ RF generator	1770		

Service the rear of the device

	Complies	Does not comply
Replace the air filter mat	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Service the sample introduction system

	Complies	Does not comply
Remove, disassemble and clean the torch	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<ul style="list-style-type: none"> Check the surface of the glass parts (injector, inner tube, outer tube and glass holder) for damage, heavily coated and broken parts. Replace glass parts, if necessary Clean glass parts in aqua regia 		
Check the sealing rings, replace if necessary	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<ul style="list-style-type: none"> Sealing rings in torch holder (3 pieces) and torch shuttle (2 pieces) Sealing rings in injector and mixing chamber mount 		
(Check sealing rings for porous and hardened areas, replace if necessary)		
Check pump tubing (sample, waste), replace if necessary	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Check peristaltic pump, disassemble and lubricate if necessary	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Check the nebulizer for damage and clean it	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Remove and clean the mixing chamber	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Check the sealing ring of the mixing chamber	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Check and clean torch height adjustment drive	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Lubricate the linear drive with a little oil	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Check the igniting pin for signs of wear	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Comments:

Service the plasma compartment

	Complies	Does not comply
Disassemble the cone, check geometry and clean it if necessary	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Take out the windows (axial/radial) and clean or replace them		
Replacing the sealing rings		
Check the surface of the first mirror, clean or replace it if necessary	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Check the air outlet for deposits and blockages, clean it if necessary	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Remove the cover plate below the plasma compartment and clean it	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Renew the filter mat		
Check the coil for its material condition, position, geometry and for the tightness of connections	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Clean or replace bonnet	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Check RF deflector spring, replace it if necessary	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Comments:

Service the spectrometer

	Complies	Does not comply
Clean and lubricate the spindle of the prism and grating with a little oil	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Check gas flows at the gas box

Gas flow	Rated value	Actual value	Complies	Does not comply
Nebulizer gas flow	0.5 L/min \pm 15 %	0.512	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Auxiliary gas flow	0.5 L/min \pm 15 %	0.506	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Cone gas flow	1,7 ... 2,8 L/min	2.7	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Oxygen is used (optional)			<input type="checkbox"/>	<input type="checkbox"/>
Oxygen flow	00.5 L/min \pm 15 %	-	<input type="checkbox"/>	<input type="checkbox"/>

Comments:

4 Maintenance work on accessories

Service the mobile cooling unit

		Complies	Does not comply
Vacuum or clean the condenser		<input checked="" type="checkbox"/>	<input type="checkbox"/>
Record the condition of the cooling water before maintenance:		<input checked="" type="checkbox"/>	<input type="checkbox"/>
Particles and discoloration present:	<input type="checkbox"/> yes <input checked="" type="checkbox"/> No		
cooling water flow rate	1.55		
Cooling water primary pressure	49 psi		
Conductivity of the cooling water	110		
Clean the water filter on the base unit (if filter is installed)		<input checked="" type="checkbox"/>	<input type="checkbox"/>
Renew cooling water		<input checked="" type="checkbox"/>	<input type="checkbox"/>
<ul style="list-style-type: none"> Prepare cooling water according to Analytik Jena's specifications Use cooling water additive from Analytik Jena 			
Check filling level of cooling water, top up if required		<input checked="" type="checkbox"/>	<input type="checkbox"/>

Cooling water circuit after maintenance

	Rated value	Actual value	Complies	Does not comply
cooling water flow rate	1.5 to 2.0 L/min	1.55	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Cooling water primary pressure	max. 6 bar (85 psi)	49 psi	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Conductivity of the cooling water	50 to 200 µS/cm	110	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Cooling water temperature (in mobile cooling unit)	18 °C	18	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Service the autosampler

	Complies	Does not comply
Check cannula and tubing to the base unit	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Check pump tubing (washing solution, waste), replace if necessary	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Clean the covers, rack mount and accessories	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Check the condition of the toothed belts for cracks, gaps and changes in color	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Check the peristaltic pump for smooth operation	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Maintenance Protocol

	Complies	Does not comply
Check the functionality of the washing cup	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Check the hose connections for leaks	<input checked="" type="checkbox"/>	<input type="checkbox"/>

5 Checking basic functions and device parameters

5.1 Check of correction functions

	Rated value (Steps)	Actual value (Steps)	Complies	Does not comply
As (193.6950 nm)	± 500	161	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Cu (324.7540 nm)	± 500	139	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Na (588.9953 nm)	± 500	101	<input checked="" type="checkbox"/>	<input type="checkbox"/>
K (766.4908 nm)	± 500	201	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Comments:

5.2 Check of safety circuits

	Complies	Does not comply
Safety circuit for torch position	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Safety circuit for door of plasma compartment	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Safety circuit for interrupted cooling water flow (cooling water flow < 0.85 L/min)	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Safety circuit for suction power (check the setting Par[85])	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Value Par[85]:		
3871		
Safety circuit for argon inlet pressure (p < 4 bar)* * if sensor is installed (Par[116] = 1)	<input type="checkbox"/>	<input type="checkbox"/>

Comments:

5.3 Check of neon energy

The plasma must be ignited for this test (CCD cooling active).

	Rated value (Steps)	Actual value (Steps)	Complies	Does not comply
585.2462 nm	> 4000 ct/s	22689	<input checked="" type="checkbox"/>	<input type="checkbox"/>
594.4807 nm	> 3000 ct/s	8138	<input checked="" type="checkbox"/>	<input type="checkbox"/>
640.2217 nm	> 3000 ct/s	31788	<input checked="" type="checkbox"/>	<input type="checkbox"/>
849.5322 nm	> 3000 ct/s	3673	<input checked="" type="checkbox"/>	<input type="checkbox"/>
607.4311 nm	> 3000 ct/s	7114	<input checked="" type="checkbox"/>	<input type="checkbox"/>
659.8923 nm	> 3000 ct/s	10809	<input checked="" type="checkbox"/>	<input type="checkbox"/>
743.8864 nm	> 3000 ct/s	3297	<input checked="" type="checkbox"/>	<input type="checkbox"/>
703.2381 nm	> 10000 ct/s	31702	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Comments:

5.4 Adjustment of transfer optics (Mn 257.610 nm)

Adjust detection (axial)		Complies	Does not comply
X offset	-0.9	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Y offset	-1.6	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Adjust detection (axial)		Complies	Does not comply
Intensity value	1996130	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Adjust detection (radial)		Complies	Does not comply
X offset	15	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Y offset	0	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Intensity value	626098	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Comments:

5.5 Verification of the wavelength accuracy, generator robustness and analytical performance

- Requirements
 - Start ASpect PQ
 - Perform measurements with the standard sample introduction kit
 - Load the sequence "maintenance_PQ9000"
 - Plasma burn-in time 15 min
 - 1 mg/L multi-element solution (Merck standard IV for ICP) in 3 % HNO₃
 - Plasma conditions 12 L/min plasma gas, 0.5 L/min auxiliary gas, 0.6 L/min nebulizer gas
 - Plasma power 1200 W
 - Measurement time 10 s
- Start the sequence "maintenance_PQ9000" (duration approx. 40 min).
The sequence automatically loads the methods that are necessary to determine the data.

Wavelength accuracy

- Open the spectra display of the measured lines one after the other. Read off the peak position (peak position before correction). Carry out the peak correction by clicking on **[Find peak center]** and read off the peak position again (peak position after correction). Calculate the difference between the two values (peak position before correction - peak position after correction).

Line	Peak position before correction	Peak position after correction	Difference Rated value	Difference Actual value
Zn 213.8560 nm	181.0 ± 2.4	181.0 ± 2.5	± 1.0	0.1
Mn (257.6100 nm)	181.0 ± 0.3	181.0 ± 0.2	± 1.0	0.1
Cu (324.7540 nm)	181.0 ± 0.1	181.0 ± 0.0	± 1.0	0.1
Li 670.7910 nm	181.0 ± -2.0	181.0 ± -2.4	± 1.0	0.4

Comments:

Robustness factor


Calculation according to the following formula:

$$F_r = \frac{\text{intensity } Mg_{280.271} / \text{intensity } BG_{Mg_{280.271}}}{\text{intensity } Mg_{285.213} / \text{intensity } BG_{Mg_{285.213}}}$$

Intensity / calculated factor	Value
Intensity Mg 280.271	1866858
Intensity BG Mg 280.271	4526
Intensity Mg 285.213	214606
Intensity BG Mg 285.213	8361
F_r	16.09

Comments:

Analytical performance

 PlasmaQuant PQ 9000 Elite

		Rated value	Actual value
Zn 213.8560 nm	Limit of detection LOD [mg/L]	< 0.0015	✓
	Recovery [%]	100 ± 10	✓
	Relative standard deviation (RSD) [%]	< 2	✓
Mn (257.6100 nm)	Limit of detection LOD [mg/L]	< 0.0002	✓
	Recovery [%]	100 ± 10	✓
	Relative standard deviation (RSD) [%]	< 1.5	✓
Cu (324.7540 nm)	Limit of detection LOD [mg/L]	< 0.0010	✓
	Recovery [%]	100 ± 10	✓
	Relative standard deviation (RSD) [%]	< 1.5	✓
Li 670.7910 nm	Limit of detection LOD [mg/L]	< 0.0025	✓
	Recovery [%]	100 ± 10	✓
	Relative standard deviation (RSD) [%]	< 1.5	✓

 PlasmaQuant PQ 9000

		Rated value	Actual value
Zn 213.8560 nm	Limit of detection LOD [mg/L]	<0.002	0.000293
	Recovery [%]	100 ± 10	98.8



		Rated value	Actual value
	Relative standard deviation (RSD) [%]	< 2	0.29
Mn (257.6100 nm)	Limit of detection LOD [mg/L]	< 0.0004	0.000037
	Recovery [%]	100 ± 10	98.7
	Relative standard deviation (RSD) [%]	< 1.5	0.34
Cu (324.7540 nm)	Limit of detection LOD [mg/L]	< 0.0015	0.000149
	Recovery [%]	100 ± 10	100.8
	Relative standard deviation (RSD) [%]	< 1.5	0.11
Li 670.7910 nm	Limit of detection LOD [mg/L]	< 0.003	0.000193
	Recovery [%]	100 ± 10	99.5
	Relative standard deviation (RSD) [%]	< 1.5	0.47

Comments:

6 Comments and objections

Comments and possible objections raised during installation and commissioning are to be recorded in writing in this section.

7 Completing maintenance

		Complies	Does not comply
Maintenance on the analyzer has been completed.		<input checked="" type="checkbox"/>	<input type="checkbox"/>
The functionality and analytical performance of the device was checked in the presence of the user. The device meets its technical specification.		<input checked="" type="checkbox"/>	<input type="checkbox"/>
Name	Function	Date	Signature
Wipawan pathumwan	Representative Customer	11/10/2022	
Mr.Pukitja Somton	Representative Analytik Jena AG	11/10/2022	

**Inctech Metrological Center Co.Ltd.**

39/1 Soi 82, Sukhapiban 5 Rd., O ngoen,

Saimai, Bangkok 10220, Thailand

Tel. (662) 909-8820 (Auto 10 lines) www.imcinstrument.com

Certificate of Calibration

Certificate No. : MC21-2398**Page** : 1 of 2**Customer** : Health & Envitech Co.,Ltd.**Address** : 77/11 M.2 Ngamwongwan Rd., Soi 5, T.Bangkheng, A.Muang Nontaburi 11000**Description** : Personal Sampler Calibrator**Manufacturer** : SKC**Model** : 303**Serial No.** : N/A**Identification No.** : LB-HE-033**Calibration Place** : Chemical Laboratory 2**Order No.** : 3361/21**Received date** : Dec 01, 2021**Calibration date** : Dec 03, 2021**Environment Condition :****Temperature** : (20+/-2) °C**Humidity** : (50+/- 15) %RH**Calibration Method** : Calibration were conducted using In-house calibration procedure *CP-MC-004* According to comparison with Analytical Balance. The calibration methods based on ASTM E542-01.**Reference Standard Instruments :**

<u>Instrument</u>	<u>Model</u>	<u>Serial No.</u>	<u>Certificate No.</u>	<u>Due Date</u>
Analytical Balance	AE-FA220	201907106	MM21-2569	Sep 01, 2022
Humidity / Baro / Temp. Data Recorder	MH-382SD	N/A	MT21-4247	Aug 09, 2022
Digital Thermometer	EFT-4	EFT42020033	MT21-2968	May 07, 2022

This result of calibration was found accurate as shown on date and place of calibration only.

Traceability : This measurement are traceable to the International System of Unit (SI), through National Institute of Metrology Thailand (NIMT)The reported uncertainty of measurement was base on standard uncertainty multiplied by coverage factor $k = 2$, providing a level of confidence of not less than 95%**Calibrated by :** Miss Nuengruethai Siripoch**Issue date :** Dec 03, 2021**Approved by :**

(Mr. Panuwat Phuklan)

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Saimai, Bangkok 10220, Thailand

Tel. (662) 909-8820 (Auto 10 lines) www.imcinstrument.com**Certificate No.** : MC21-2398**Page** : 2 of 2**Result** : Without adjustment**Calibration Point** : 50, 90, 100, 110 ml

Nominal value (ml)	Standard reading (ml)	UUC* correction (ml)	Uncertainty of measurement (+/- ml)
50	50.0156	0.0156	0.056
90	90.0193	0.0193	0.063
100	100.0256	0.0256	0.063
110	110.0276	0.0276	0.073

UUC* = Unit under calibration

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Saimai, Bangkok 10220, ThailandTel. (662) 909-8820 (Auto 10 lines) www.imcinstrument.com

Certificate of Calibration

Certificate No. : MC22-2790

Page : 1 of 2

Customer : Health & Envitech Co.,Ltd.

Address : 77/11 M.2 Ngamwongwan Rd., Soi 5, T.Bangkheng, A.Muang Nontaburi 11000

Description : Personal Sampler Calibrator

Manufacturer : SKC

Model : 303

Serial No. : N/A

Identification No. : PC-001

Calibration Place : Chemical Laboratory 2

Order No. : 3486/22

Received date : Nov 28, 2022

Calibration date : Nov 29, 2022

Environment Condition :

Temperature : (20+/-2) °C

Humidity : (50+/- 15) %RH

Calibration Method : Calibration were conducted using In-house calibration procedure *CP-MC-004* According to comparison with Analytical Balance. The calibration methods based on ASTM E542-01.

Reference Standard Instruments :

<u>Instrument</u>	<u>Model</u>	<u>Serial No.</u>	<u>Certificate No.</u>	<u>Due Date</u>
Analytical Balance	AE-FA220	201907106	MM22-2494	Aug 29, 2023
Humidity / Baro / Temp. Data Recorder	MH-382SD	N/A	MT22-4415	Jul 27, 2023
Digital Thermometer	EFT-4	EFT42020033	MT22-3124	May 03, 2023

This result of calibration was found accurate as shown on date and place of calibration only.

Traceability : This measurement are traceable to the International System of Unit (SI), through National Institute of Metrology Thailand (NIMT)

The reported uncertainty of measurement was based on standard uncertainty multiplied by coverage factor $k = 2$, providing a level of confidence of not less than 95%



Calibrated by : Miss Nuengruethai Siripoch

Issue date : Nov 29, 2022

Approved by :

(Mr.Chooiphong Khumdet)

This calibration certificate shall not be reproduced other than in full except with the prior written approval of Inctech Metrological Center Co.,Ltd

**Inctech Metrological Center Co.Ltd.**

39/1 Soi 82, Sukhapiban 5 Rd., O ngoen,

Saimai, Bangkok 10220, Thailand

Tel. (662) 909-8820 (Auto 10 lines) www.imcinstrument.com**Certificate No.** : MC22-2790**Page** : 2 of 2**Result** : Without adjustment**Calibration Point** : 50, 90, 100, 110 ml

Nominal value (ml)	Standard reading (ml)	UUC* correction (ml)	Uncertainty of measurement (+/- ml)
50	50.0176	0.0176	0.056
90	90.0217	0.0217	0.063
100	100.0269	0.0269	0.063
110	110.0290	0.0290	0.073

UUC* = Unit under calibration

Certificate of Calibration

Certificate No. : 65-420050-2

Page : 1 of 2

Submitted by : Health & Envitech Co., Ltd.

6 Ngamwongwan Rd., Soi 5, T.Bangkhen, A.Muang, Nonthaburi 11000

Equipment : pH Meter with electrode

pH meter

Manufacturer : Hanna

Model : HI 3220

Range : -2.00 to 20.00 pH

Resolution : 0.01 pH

Serial No. : 08631549

ID No. : LB-HE-051

Electrode

Model : HI 1131

Serial No. : 0438399N

Environment : Ambient Temperature : $(25 \pm 2) ^\circ \text{C}$

Relative Humidity : $(50 \pm 15) \%$

Date of Received : 22 June 2022

Date of Calibration : 28 June 2022

Date of Issue : 28 June 2022

Calibrated by : Bunjerd Masri

Calibration Method : In-house method CAL-M4201 direct measurement by using standard voltage calibrator and using certified reference material (CRM)

Reference Standard Instruments : This certification is traceable to the International System of Units

1. Multiproduct Calibrator

ID No.	Cert. No.	Due Date	Traceability
440001	21E997	17 Mar 2023	National Institute of Metrology Thailand (NIMT)

2. Standard Buffer Solution

pH	Cert. No.	Lot No.	Exp. Date	Traceability
4.008	61235182	795894	14 Feb 2024	CPA Chem Ltd. Accredited to ISO 17034 and ISO/IEC 17025
6.985	61243095	809356	21 Apr 2023	CPA Chem Ltd. Accredited to ISO 17034 and ISO/IEC 17025
10.008	61244986	795895	25 Feb 2023	CPA Chem Ltd. Accredited to ISO 17034 and ISO/IEC 17025

Approved by :



(Bunjerd Masri)

Supervisor



Certificate of Calibration

Certificate No. : 65-420050-2

Page : 2 of 2

Result of Calibration :

UUC Condition As-Received : Good

Function : Electrical measurement

pH meter

Performing standard curve by Multiproduct Calibrator at pH (4,7,10)

Adjustment Curve at nominal pH	Applied Voltage (mV)	Nominal Value (pH)	UUC Reading		Correction (mV)	Uncertainty (± mV)
			(pH)	(mV)		
4, 7, 10	177.4800	4	4.00	177.3	0.2	0.060
	0.0000	7	7.00	-0.1	0.1	0.060
	-177.4800	10	10.00	-177.5	0.0	0.060

Function : pH meter with electrode

Performing a three - buffer standard curve using buffer nominal pH (4,7,10)

Adjustment Curve at nominal pH	Standard Buffer (pH)	UUC Reading (pH)	Correction (pH)	Uncertainty (± pH)
4, 7, 10	4.008	4.01	0.00	0.010
	6.985	7.01	-0.02	0.012
	10.008	10.01	0.00	0.014

Remark

UUC : Unit Under Calibration

This result of calibration was found accurate as shown on date and place of calibration only.

This reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%

- oOo -

B✓



Certificate of Calibration

Certificate No. : 65-400340-1

Page : 1 of 2

Submitted by : Health & Envitech Co., Ltd.
6 Ngamwongwan Rd., Soi 5, T.Bangkhen, A.Muang, Nonthaburi 11000

Equipment : Digital Thermometer with Thermistor Probe (Temp pH)
Temperature Indicator
Manufacturer : Hanna Model : HI3220
Range : N/A Resolution : 0.1 °C
Serial No. : 08631549 ID No. : LB-HE-051
Thermistor Probe
Model : N/A Sheath Material : Stainless
Diameter : 3.5 mm. Length : 100 mm.
Serial No. : TH 050363 ID No. : LB-HE-051

Environment : Ambient Temperature : (23 ± 2) °C
Relative Humidity : (50 ± 15) %
Line Voltage : (220 ± 22) VAC

Date of Received : 22 June 2022

Date of Calibration : 28 June 2022

Date of Issue : 28 June 2022

Calibrated by : Bunjerd Masri

Calibration Method : This instrument was calibrated by In-house method comparison technique CAL-M4003 by compared with PRT in the liquid bath at the constant controlled temperature.

The temperature scale used was based on ITS-90

Reference Standard Instruments : This certification is traceable to the International System of Units

1. Platinum Resistance Thermometer (PRT)

ID No.	Cert. No.	Due Date	Traceability
400001	TT-0016-22	07 Feb 2024	National Institute of Metrology Thailand (NIMT)

2. Standard Digital Thermometer

ID No.	Cert. No.	Due Date	Traceability
400003	21E1850	14 Jun 2023	National Institute of Metrology Thailand (NIMT)
400004	21E1850	14 Jun 2023	National Institute of Metrology Thailand (NIMT)

Approved by :

(Bunjerd Masri)

Supervisor

The Uncertainties are for a confidence probability of approximately 95%

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Certificate of Calibration

Certificate No. : 65-400340-1

Page : 2 of 2

Result of Calibration : Without Adjustment

UUC Condition As-Received : Good

Function : Temperature measurement

Immersion Depth (mm.)	Standard Reading (°C)	UUC Reading (°C)	Correction (°C)	Uncertainty (± °C)
100	25.0033	25.0	0.0	0.12
100	35.0028	35.0	0.0	0.12
100	45.0037	45.0	0.0	0.12

Remark

UUC : Unit Under Calibration

This result of calibration was found accurate as shown on date and place of calibration only.

This reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%

- oOo -





Certificate of Calibration

Certificate Number : SPR23010088-2

Page : 1 of 3

Customer : Health and Envitech Co., Ltd

6 Ngamwongwan Road, Soi 5, Bang Khen, Mueang Nonthaburi,
Nonthaburi 11000

Equipment Name : Sound Level Meter

Manufacturer : ACO

Model : 6236

Serial Number : 82895

ID. Number : S-004

Environmental Conditions

Ambient Temperature : $23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$

Relative Humidity : $50\% \pm 15\%$

Location of Calibration : In-Lab

Calibration Procedure : SP-CPE-04-01

Received Date : 10 Jan 2023

Calibration Date : 13 Jan 2023

Recommend Due Date : N/A

Date of Issue : 14 Jan 2023

Method of Calibration

This certifies that the above instrument was calibrated in compliance with the calibration system requirement of ISO/IEC 17025:2017 in accordance with reference procedure. Standards used to perform this calibration are certified by to NIST or equivalent, National metrology institute, Natural physical constants, consensus standards. The result reported herein apply only to the calibration of the item described above as received. Our decision rule is to contact the customer if the item pass and fail calibration when the results include the uncertainties and the customer must determine if the results meets their needs.

All calibrations are performed within manufacture's specifications. The calibration certificate shall not be reproduced except in full, without written approval of SP Metrology System (Thailand).

Calibrated by : Mr. Karoon Pengsalung

Calibration Officer

Approved by :

(Ms. Bussakorn Chaikaew)

Authorized Signatory



Calibration Report

Certificate Number : SPR23010088-2

Page : 2 of 3

Reference Standards

Equipment Name	Model	Serial No.	Certificate No.	Due. Date
Sound Level Calibrator	SC-942	B014059	EEL.BP. 34/1264	22 Dec 2023

Traceability

This certification is traceable to the International System of Unit maintained at :
TISTR - Thailand Institute of Scientific and Technological Research



Result of Calibration

Certificate No. : SPR23010088-2

Page : 3 of 3

Range : 94 to 114 dB

Function : @1kHz

Select A

Unit : dB

Standard Setting	UUC Reading		Error		Uncertainty (±)
	Fast	Slow	Fast	Slow	
94	94.0	94.0	0.0	0.0	0.15
114	113.7	113.7	-0.3	-0.3	0.15

Select C

Unit : dB

Standard Setting	UUC Reading		Error		Uncertainty (±)
	Fast	Slow	Fast	Slow	
94	94.1	94.1	0.1	0.1	0.15
114	113.5	113.5	-0.5	-0.5	0.15

Note:

The result of calibration was found accurate as show on date and place of calibration only.
This Certificate is not certified for any commercial transaction.

Measurement Uncertainty

The reported uncertainty of measurement is the expanded uncertainty obtained by multiplying the standard uncertainty with the coverage factor $k = 2.00$, providing a level of confidence approximately 95%.

- End of Certificate -



Certificate of Calibration

Certificate Number : SPR23010088-1

Page : 1 of 3

Customer : Health and Envitech Co., Ltd

6 Ngamwongwan Road, Soi 5, Bang Khen, Mueang Nonthaburi,
Nonthaburi 11000

Equipment Name : Sound Level Meter

Manufacturer : ACO

Model : 6236

Serial Number : 82896

ID. Number : S-005

Environmental Conditions

Ambient Temperature : $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$

Relative Humidity : $50\% \pm 15\%$

Location of Calibration : In-Lab

Calibration Procedure : SP-CPE-04-01

Received Date : 10 Jan 2023

Calibration Date : 13 Jan 2023

Recommend Due Date : N/A

Date of Issue : 14 Jan 2023

Method of Calibration

This certifies that the above instrument was calibrated in compliance with the calibration system requirement of ISO/IEC 17025:2017 in accordance with reference procedure. Standards used to perform this calibration are certified by to NIST or equivalent, National metrology institute, Natural physical constants, consensus standards. The result reported herein apply only to the calibration of the item described above as received. Our decision rule is to contact the customer if the item pass and fail calibration when the results include the uncertainties and the customer must determine if the results meets their needs.

All calibrations are performed within manufacture's specifications. The calibration certificate shall not be reproduced except in full, without written approval of SP Metrology System (Thailand).

Calibrated by : Mr. Karoon Pengsalung

Calibration Officer

Approved by :

(Ms. Bussakorn Chaikaew)

Authorized Signatory



Calibration Report

Certificate Number : SPR23010088-1

Page : 2 of 3

Reference Standards

Equipment Name	Model	Serial No.	Certificate No.	Due. Date
Sound Level Calibrator	SC-942	B014059	EEL.BP. 34/1264	22 Dec 2023

Traceability

This certification is traceable to the International System of Unit maintained at :
TISTR - Thailand Institute of Scientific and Technological Research



Result of Calibration

Certificate No. : SPR23010088-1

Page : 3 of 3

Range : 94 to 114 dB

Function : @1kHz

Select A

Unit : dB

Standard Setting	UUC Reading		Error		Uncertainty (±)
	Fast	Slow	Fast	Slow	
94	94.0	94.0	0.0	0.0	0.15
114	113.9	113.9	-0.1	-0.1	0.15

Select C

Unit : dB

Standard Setting	UUC Reading		Error		Uncertainty (±)
	Fast	Slow	Fast	Slow	
94	94.1	94.1	0.1	0.1	0.15
114	113.6	113.6	-0.4	-0.4	0.15

Note:

The result of calibration was found accurate as show on date and place of calibration only.
This Certificate is not certified for any commercial transaction.

Measurement Uncertainty

The reported uncertainty of measurement is the expanded uncertainty obtained by multiplying the standard uncertainty with the coverage factor $k = 2.00$, providing a level of confidence approximately 95%.

- End of Certificate -

Request No. 21-66/0225

MTC No. EEL. BP. 164/0166

CALIBRATION CERTIFICATE

Submitted by : HEALTH & ENVITECH CO., LTD.

Address : 6 Ngamwongwan Rd., Soi 5, T. Bangkhen, A. Muang, Nontaburi 11000.

Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre.
: Soi 1C, Bangpoo Industrial Estate, Sukhumvit Rd., Muang, Samutprakan 10280.

Instrument Calibrated :

Description : Sound Calibrator

Manufacturer : Quest Electronics

Model : QC-10

Serial No. : QE7060323 (ID. NO : SC-002)

Ambient Environment

Temperature : $(23 \pm 3) ^\circ\text{C}$

Relative Humidity : $(50 \pm 15) \%$

Ambient Pressure : $(101.325 \pm 1.500) \text{ kPa}$

Standards used : 1. Digital Function Synthesizer NF Electronic DF-193A S/N 122037.
2. Measuring Amplifier Bruel&Kjaer 2636 S/N 1537484.
3. Programmable Attenuator Tamagawa TPA-303A S/N OF 2214.
4. Digital Multimeter Agilent 34401A S/N MY44005560.
5. Pressure Transmitter Vaisala PTB202AD S/N T0650001.
6. Audio Analyzer Keithley 2015-P S/N 4106495.
7. Condenser Microphone Bruel&Kjaer 4180 S/N 2889871.

Calibration Procedure: CP-102-04 based on IEC 60942-2003. The sound pressure level of instrument was measured by standard microphone using an insert voltage technique.

This instrument has been calibrated against standards maintained at Electrical and Electronic Standards Laboratory (EEL), which are traceable to the International System of Units through the National Institute of Metrology (Thailand).

The information on actual reading is attached herewith and the uncertainty limits quoted refer to the measured values only.

Date of Receipt : 16 Jan. 2023

Date of Calibration : 24 Jan. 2023

1 / 2



The results relate only to the items tested/calibrated or value assigned.

Advertising the Report/Certificate and publicity of the results except in full are prohibited unless written permission is obtained from the governor of TISTR.

FM.BL.MTC.002 Rev.4

Head Office

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0225

MTC No. EEL. BP. 164/0166

The reported expanded uncertainty is based upon a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%.

Nominal Output of Unit Under Test = 114 dB re 20 μ Pa at 1000 Hz

Acoustic Output in dB re 20 μ Pa, Corrected to Reference Conditions: 101.325 kPa, 23.0 °C and 50 %RH.

1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	114.09	0.09	± 0.10	± 0.40 dB

2. Frequency

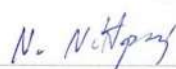
Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	1003.4	3.4	± 1.5	± 1.0 %

3. Total Distortion

Standard Microphone Type	Measured Total Distortion (%)	Uncertainty (%)	Tolerance limit IEC60942:2003 Class 1
1/2 inch Bruel&Kjaer 4180	0.82	± 0.50	± 3.0 %

- Note :
1. No adjustment.
 2. The calibrator pressure correction was not included.
 3. The microphone volume correction was not included.

Calibrated by :


(Mr. Nuttapong Niljrusvanit)

Approved by :


(Mr. Prawate Kluaypa)
Director

Electrical and Electronic Standards Laboratory

Industrial Metrology and Testing Service Centre

Date of Calibration : 24 Jan. 2023

Date of Issue : 25 Jan. 2023

Ref : 2011266011600175002

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End of Certificate

The results relate only to the items tested/calibrated or value assigned.
Advertising the Report/Certificate and publicity of the results except in full are prohibited unless written permission is obtained from the governor of TISTR.

FM.BL.MTC.002 Rev.4

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CERTIFICATE OF CALIBRATION

NO. 20221215040

Name of Product:	Sound Level Meter
Model:	ST-11D
Serial Number:	820371
Specification:	Class 1
Conclusion:	Pass
Date of calibration:	2022-12-15
Due Date:	2023-12-14

Calibrated by: *Jim Lin*

- I. This report certifies that all calibration equipment used in the test is traceable with the internal ISO9001 procedures and meets all specification given in the Manual(s) or respectively surpass then, and applies only to the unit identified above.
- II. This certificate is produced with advanced equipment & procedures which permit comprehensive quality assurance verification of all data supplied herein.
- III. This certificate of calibration shall not be reproduced except in full, without written permission of the Scarlet Tech Co Ltd Taiwan.

1. Preliminary inspection: OK

2. Type & serial No. of Microphone: AWA14425-54875

4. Measuring up limit: 140 dBA

3. Adjustments to indicated sound levels:

5. Frequency weightings (Acoustic signal tests for Z weighting, other electric signal tests.)

Type of Calibrator B&K 4231

Sound Pressure Level 94.0 dB

Equivalent Free-field Sound Level (reference environment conditions) 93.8 dB

Nominal frequency /Hz	Frequency weighting / dB			Nominal frequency /Hz	Frequency weighting / dB		
	A	C	Z		A	C	Z
10	-71.0	-14.6	-0.2	1000	0.0	0.0	-0.1
20	-50.3	-6.1	-0.4	2000	0.1	0.0	0.0
31.5	-39.5	-3.0	-0.2	4000	1.3	-0.1	0.0
63	-26.2	-0.8	-0.1	8000	1.2	-0.7	0.0
125	-16.1	-0.2	0.0	12500	-5.6	-7.8	0.0
250	-8.6	0.0	0.0	16000	-11.7	-13.7	0.1
500	-3.2	0.0	0.0	20000	-23.8	-25.9	-0.6

6. Self-generated noise

Microphone replaced by electrical input signal device

8.1 dB(A)	8.7 dB(C)	13.4 dB(Z)
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7. F&S Weighting

Rate of the F weighting decrease (dB/s)	35.2
Rate of the S weighting decrease (dB/s)	4.3
Deviation of F&S	0.0

8. Level Linearity (A-weighting at frequency 1 kHz)

Reference sound level 90.0 dB

Max error at 10dB steps upper reference sound level -0.1 dB

Max error at 1dB steps within 5dB of the upper limit linear operating range 0.0 dB

Max error at 10dB steps below reference sound level 0.1 dB

Max error at 1dB steps within 5dB upper the lower limit linear operating range 0.1 dB

9. Tone burst response (A Weighting) :

Single Toneburst duration /ms	Toneburst response /dB			
	$L_{AFmax}-L_A$	$L_{ASmax}-L_A$	$L_{AE}-L_A$	$L_{AeqT}-L_A$
500	0.0	-4.0	-2.9	-7.0
200	-1.0	-7.4	-6.9	-7.0
50	-18.0	-26.9	-26.9	-7.0
10	-27.2	/	-36.0	-7.0

10. Peak C sound level (500Hz) :

Cycle	One cycle	nominal value	Positive half	nominal value	Negative half	nominal value
LCpeak-LC(dB)	3.5	3.5	2.3	2.4	2.3	2.4

11. Overload indication: Pass

12. Statistical analysis function

Sweep signal maximum indicated sound level: 112.8 dB

Sweep amplitude: 40 dB

Scan cycle time: 60 S; Measurement period: 180 S.

Items	Measured value/dB	Theoretical calculated value/dB	Error/dB
L _{Aeq,T}	103.2	103.2	0.0
L ₅	110.8	110.8	0.0
L ₁₀	108.8	108.8	0.0
L ₅₀	92.9	92.8	0.1
L ₉₀	76.9	76.8	0.1
L ₉₅	75.0	74.9	0.1

Uncertainty of measurement results: 0.4 dB (k=2)

Environment conditions:

Air temperature: 20 °C
Relative humidity: 60 %
Static pressure: 101.8 kPa

References:

IEC 61672-3 Sound Level Meters Part 3: Periodic tests

CERTIFICATE OF CALIBRATION

NO. 20221215041

Name of Product:	Sound Level Meter
Model:	ST-11D
Serial Number:	820372
Specification:	Class 1
Conclusion:	Pass
Date of calibration:	2022-12-15
Due Date:	2023-12-14

Calibrated by: *Jim Lim*

- I. This report certifies that all calibration equipment used in the test is traceable with the internal ISO9001 procedures and meets all specification given in the Manual(s) or respectively surpass then, and applies only to the unit identified above.
- II. This certificate is produced with advanced equipment & procedures which permit comprehensive quality assurance verification of all data supplied herein.
- III. This certificate of calibration shall not be reproduced except in full, without written permission of the Scarlet Tech Co Ltd Taiwan.

1. Preliminary inspection: OK

2. Type & serial No. of Microphone: AWA14425-52842

4. Measuring up limit: 140 dBA

3. Adjustments to indicated sound levels:

5. Frequency weightings (Acoustic signal tests for Z weighting, other electric signal tests.)

Type of Calibrator B&K 4231

Sound Pressure Level 94.0 dB

Equivalent Free-field Sound Level (reference environment conditions) 93.8 dB

Nominal frequency /Hz	Frequency weighting / dB			Nominal frequency /Hz	Frequency weighting / dB		
	A	C	Z		A	C	Z
10	-71.1	-14.6	-0.2	1000	0.0	0.0	-0.1
20	-50.3	-6.1	-0.4	2000	0.1	0.0	0.0
31.5	-39.5	-3.0	-0.2	4000	1.3	-0.1	0.0
63	-26.2	-0.8	-0.1	8000	1.2	-0.7	0.0
125	-16.2	-0.2	0.0	12500	-5.8	-7.8	0.0
250	-8.6	0.0	0.0	16000	-11.7	-13.6	0.1
500	-3.2	0.0	0.0	20000	-23.8	-25.8	-0.6

6. Self-generated noise

Microphone replaced by electrical input signal device

9.6 dB(A)	10.4 dB(C)	14.5 dB(Z)
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7. F&S Weighting

Rate of the F weighting decrease (dB/s)	35.2
Rate of the S weighting decrease (dB/s)	4.2
Deviation of F&S	0.0

8. Level Linearity (A-weighting at frequency 1 kHz)

Reference sound level 90.0 dB

Max error at 10dB steps upper reference sound level -0.1 dB

Max error at 1dB steps within 5dB of the upper limit linear operating range 0.0 dB

Max error at 10dB steps below reference sound level 0.1 dB

Max error at 1dB steps within 5dB upper the lower limit linear operating range 0.1 dB

9. Tone burst response (A Weighting) :

Single Toneburst duration /ms	Toneburst response /dB			
	$L_{AFmax}-L_A$	$L_{ASmax}-L_A$	$L_{AE}-L_A$	$L_{AeqT}-L_A$
500	0.0	-4.0	-2.9	-7.0
200	-1.0	-7.4	-6.9	-7.0
50	-18.0	-26.9	-26.9	-7.0
10	-27.1	/	-36.0	-7.0

10. Peak C sound level (500Hz) :

Cycle	One cycle	nominal value	Positive half	nominal value	Negative half	nominal value
LCpeak-LC(dB)	3.4	3.5	2.3	2.4	2.3	2.4

11. Overload indication: Pass

12. Statistical analysis function

Sweep signal maximum indicated sound level: 112.8 dB

Sweep amplitude: 40 dB

Scan cycle time: 60 S; Measurement period: 180 S.

Items	Measured value/dB	Theoretical calculated value/dB	Error/dB
L _{Aeq,T}	103.2	103.2	0.0
L ₅	110.8	110.8	0.0
L ₁₀	108.8	108.8	0.0
L ₅₀	92.9	92.8	0.1
L ₉₀	76.9	76.8	0.1
L ₉₅	75.0	74.9	0.1

Uncertainty of measurement results: 0.4 dB (k=2)

Environment conditions:

Air temperature: 20 °C

Relative humidity: 60 %

Static pressure: 101.8 kPa

References:

IEC 61672-3 Sound Level Meters Part 3: Periodic tests

CERTIFICATE OF CALIBRATION

NO. 20221215043

Name of Product:	Sound Level Meter
Model:	ST-11D
Serial Number:	820376
Specification:	Class 1
Conclusion:	Pass
Date of calibration:	2022-12-15
Due Date:	2023-12-14

Calibrated by: *Jim Lim*

- I. This report certifies that all calibration equipment used in the test is traceable with the internal ISO9001 procedures and meets all specification given in the Manual(s) or respectively surpass then, and applies only to the unit identified above.
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- III. This certificate of calibration shall not be reproduced except in full, without written permission of the Scarlet Tech Co Ltd Taiwan.

1. Preliminary inspection: OK

2. Type & serial No. of Microphone: AWA14425-52146

4. Measuring up limit: 140 dBA

3. Adjustments to indicated sound levels:

5. Frequency weightings (Acoustic signal tests for Z weighting, other electric signal tests.)

Type of Calibrator B&K 4231

Sound Pressure Level 94.0 dB

Equivalent Free-field Sound Level (reference environment conditions) 93.8 dB

Nominal frequency /Hz	Frequency weighting / dB			Nominal frequency /Hz	Frequency weighting / dB		
	A	C	Z		A	C	Z
10	-71.1	-14.6	-0.1	1000	0.0	0.0	-0.1
20	-50.4	-6.2	-0.3	2000	0.0	0.0	-0.1
31.5	-39.4	-3.0	-0.3	4000	1.3	-0.2	-0.1
63	-26.2	-0.8	-0.1	8000	1.1	-0.7	-0.1
125	-16.2	-0.2	-0.1	12500	-5.8	-7.8	0.0
250	-8.7	0.0	-0.1	16000	-11.7	-13.2	0.1
500	-3.2	0.0	-0.1	20000	-23.5	-25.8	-0.6

6. Self-generated noise

Microphone replaced by electrical input signal device

9.5 dB(A)	10.1 dB(C)	14.6 dB(Z)
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7. F&S Weighting

Rate of the F weighting decrease (dB/s)	35.2
Rate of the S weighting decrease (dB/s)	4.2
Deviation of F&S	0.0

8. Level Linearity (A-weighting at frequency 1 kHz)

Reference sound level 90.0 dB

Max error at 10dB steps upper reference sound level -0.1 dB

Max error at 1dB steps within 5dB of the upper limit linear operating range 0.0 dB

Max error at 10dB steps below reference sound level 0.1 dB

Max error at 1dB steps within 5dB upper the lower limit linear operating range 0.1 dB

9. Tone burst response (A Weighting) :

Single Toneburst duration /ms	Toneburst response /dB			
	$L_{AFmax}-L_A$	$L_{ASmax}-L_A$	$L_{AE}-L_A$	$L_{AeqT}-L_A$
500	0.0	-4.0	-2.9	-7.0
200	-1.0	-7.4	-6.9	-7.0
50	-18.0	-26.9	-26.9	-7.0
10	-27.2	/	-36.0	-7.0

10. Peak C sound level (500Hz) :

Cycle	One cycle	nominal value	Positive half	nominal value	Negative half	nominal value
LCpeak-LC(dB)	3.5	3.5	2.3	2.4	2.3	2.4

11. Overload indication: Pass

12. Statistical analysis function

Sweep signal maximum indicated sound level: 112.8 dB

Sweep amplitude: 40 dB

Scan cycle time: 60 S; Measurement period: 180 S.

Items	Measured value/dB	Theoretical calculated value/dB	Error/dB
L _{Aeq,T}	103.2	103.2	0.0
L ₅	110.8	110.8	0.0
L ₁₀	108.8	108.8	0.0
L ₅₀	92.9	92.8	0.1
L ₉₀	76.9	76.8	0.1
L ₉₅	75.0	74.9	0.1

Uncertainty of measurement results: 0.4 dB (k=2)

Environment conditions:

Air temperature: 20 °C
Relative humidity: 60 %
Static pressure: 101.8 kPa

References:

IEC 61672-3 Sound Level Meters Part 3: Periodic tests

CERTIFICATE OF CALIBRATION

NO. 20221215044

Name of Product:	Sound Level Meter
Model:	ST-11D
Serial Number:	820377
Specification:	Class 1
Conclusion:	Pass
Date of calibration:	2022-12-15
Due Date:	2023-12-14

Calibrated by: *Jim Lin*

- I. This report certifies that all calibration equipment used in the test is traceable with the internal ISO9001 procedures and meets all specification given in the Manual(s) or respectively surpass then, and applies only to the unit identified above.
- II. This certificate is produced with advanced equipment & procedures which permit comprehensive quality assurance verification of all data supplied herein.
- III. This certificate of calibration shall not be reproduced except in full, without written permission of the Scarlet Tech Co Ltd Taiwan.

1. Preliminary inspection: OK

2. Type & serial No. of Microphone: AWA14425-50891

4. Measuring up limit: 140 dBA

3. Adjustments to indicated sound levels:

5. Frequency weightings (Acoustic signal tests for Z weighting, other electric signal tests.)

Type of Calibrator B&K 4231

Sound Pressure Level 94.0 dB

Equivalent Free-field Sound Level (reference environment conditions) 93.8 dB

Nominal frequency /Hz	Frequency weighting / dB			Nominal frequency /Hz	Frequency weighting / dB		
	A	C	Z		A	C	Z
10	-71.1	-14.6	-0.1	1000	0.0	0.0	-0.1
20	-50.3	-6.1	-0.2	2000	0.1	0.1	0.0
31.5	-39.3	-2.9	0.0	4000	1.4	-0.1	0.0
63	-26.1	-0.8	0.0	8000	1.2	-0.7	0.0
125	-16.1	-0.1	0.0	12500	-5.8	-7.8	0.0
250	-8.6	0.1	0.0	16000	-11.3	-13.6	0.0
500	-3.1	0.1	0.0	20000	-23.5	-25.8	-0.6

6. Self-generated noise

Microphone replaced by electrical input signal device

7.3 dB(A)	7.8 dB(C)	14.8 dB(Z)
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7. F&S Weighting

Rate of the F weighting decrease (dB/s)	35.2
Rate of the S weighting decrease (dB/s)	4.4
Deviation of F&S	-0.1

8. Level Linearity (A-weighting at frequency 1 kHz)

Reference sound level 90.0 dB

Max error at 10dB steps upper reference sound level -0.1 dB

Max error at 1dB steps within 5dB of the upper limit linear operating range 0.0 dB

Max error at 10dB steps below reference sound level 0.1 dB

Max error at 1dB steps within 5dB upper the lower limit linear operating range 0.1 dB

9. Tone burst response (A Weighting) :

Single Toneburst duration /ms	Toneburst response /dB			
	$L_{AFmax}-L_A$	$L_{ASmax}-L_A$	$L_{AE}-L_A$	$L_{AeqT}-L_A$
500	0.0	-4.0	-2.9	-7.0
200	-1.0	-7.4	-6.9	-7.0
50	-18.1	-26.9	-26.9	-7.0
10	-27.2	/	-36.0	-7.0

10. Peak C sound level (500Hz) :

Cycle	One cycle	nominal value	Positive half	nominal value	Negative half	nominal value
LCpeak-LC(dB)	3.5	3.5	2.4	2.4	2.3	2.4

11. Overload indication: Pass

12. Statistical analysis function

Sweep signal maximum indicated sound level: 112.8 dB

Sweep amplitude: 40 dB

Scan cycle time: 60 S; Measurement period: 180 S.

Items	Measured value/dB	Theoretical calculated value/dB	Error/dB
L _{Aeq,T}	103.2	103.2	0.0
L ₅	110.8	110.8	0.0
L ₁₀	108.8	108.8	0.0
L ₅₀	92.9	92.8	0.1
L ₉₀	76.9	76.8	0.1
L ₉₅	75.0	74.9	0.1

Uncertainty of measurement results: 0.4 dB (k=2)

Environment conditions:

Air temperature: 20 °C
Relative humidity: 60 %
Static pressure: 101.8 kPa

References:

IEC 61672-3 Sound Level Meters Part 3: Periodic tests

Calibration Certificate

Date of Issue 01 November 2022 Page : 1 of 2
Object Wind speed and wind direction
Manufacture NRG Instruments
Type Sensor : NRG 40C, 200P
Serial No Basic Datalogger : 309017846
Customer Health & Envitech CO.,Ltd.
6 Ngamwongwan Rd.Soi 5, Tumbon Bangkhen, Muang,Nontaburi 11000

Calibration Condition : Temperature 25.2 °C Barometric Pressure 1012.8 hPa
NATIONAL STANDARD WIND TUNNEL : Thermal Anemometer 642 S/N 91563
: HOOK GAGE NO 1425 : Wind Aloft Plotting Board
N.I.S.T. Test Reference Number 731/241460
: Ultrasonic Anemometer Model DA-650-3TV (sensor TR-90AH)
Serial Number 110730029 (sensor 120629586)
JAPAN QUALITY ASSURANCE ORGANIZATION
: Theodor Friedrich : Dry No. 8390/94 Wet No.
STANDARD THERMOMETER 8389/94
: Thermoschneider No. 918802
STANDARD BAROMETER : Digital Barometer Vaisala Type RTB220 No. V1220015

Calibrated by :



Mr. Pasagorn Samol

The Result of Calibration

Date of Issue 01 November 2022

Page : 2 of 2

Standard Ultrasonic Anemometer m/sec	HOOK GAGE NO 1425			TESTED ANEMOMETER			
	Pressure inches	Vacuum inches	Pressure hPa	Pressure hPa	Correction hPa	Velocity m/sec	Correction m/sec
1.00	-	-	-	-	-	0.9	0.10
3.02	-	-	-	-	-	2.9	0.12
5.04	-	-	-	-	-	4.8	0.24
7.03	-	-	-	-	-	6.8	0.23
9.01	-	-	-	-	-	8.7	0.31
11.03	-	-	-	-	-	10.7	0.33
13.01	-	-	-	-	-	12.5	0.51
15.03	-	-	-	-	-	14.1	0.93
17.05	-	-	-	-	-	16.4	0.65
20.02	-	-	-	-	-	19.1	0.92

Wind Aloft Plotting Board. US. DEPARTMENT OF COMMERCE WEATHER BUREAU	
WIND DIRECTION	TESTED WIND DIRECTION
0	0
90	90
180	180
270	270

Calibrated by :



Mr. Pasagorn Samol



Certificate of Calibration

Method 5 Pre-Test Calibration - Liters (L)

UUT Meter Console Information

Model #:	XC-572-V
Serial #:	A1912535
DGM Model #:	SK25EX
DGM Serial #:	00006056

Calibration Conditions

Bar. Pressure (mm Hg):	758.3
Ambient Temperature (°C):	25.6
Relative Humidity (%):	40
Altitude (m):	1.83
Bar. Pressure Corr. (mm Hg):	758.2

Factors/Conversions

Std. Temp. (K):	293.15
Std. Press. (mm Hg):	760
K ₁ (K/mm Hg):	0.3857

Reference Equipment

Calibration Meter Model:	DGMR-200H
Cal. Date:	03-Jun-22
Serial No.:	0000026
Gamma:	1.0000

UUT Meter (DGM)

Run Time (seconds)	Orifice, ΔH (mm H ₂ O)	Volume		Meter Temperature (°C)		Meter Pressure (mm H ₂ O)		Volume (L)		Outlet Temperature (°C)	
		Initial (L)	Final (L)	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Θ	P _{m(g)}	V _m	V _m	t _m	t _m	P _w	P _w	V _w	V _w	t _w	t _w
840.00	13.00	148542.0	148705.2	25.0	25.0	0.3	0.3	0.00	164.61	25.0	25.0
600.00	25.00	148705.2	148858.4	25.0	25.0	0.5	0.5	0.00	154.10	25.0	25.0
453.00	50.00	148858.4	149024.2	25.0	26.0	0.6	0.6	0.00	166.50	25.0	25.0
370.00	80.00	149024.2	149192.8	26.0	26.0	2.0	2.0	0.00	171.82	25.0	25.0
310.00	120.00	149192.8	149363.6	26.0	27.0	2.4	2.4	0.00	174.51	25.0	25.0

Reference Meter (WTM)

Volume (L)		Total		Outlet Temperature (°C)	
Initial	Final	Initial	Final	Initial	Final
V _w	V _w	V _w	V _w	t _w	t _w
164.61	164.61	164.61	164.61	25.0	25.0
154.10	154.10	154.10	154.10	25.0	25.0
166.50	166.50	166.50	166.50	25.0	25.0
171.82	171.82	171.82	171.82	25.0	25.0
174.51	174.51	174.51	174.51	25.0	25.0

Standardized Data

Reference Meter (L)		UUT Meter (L)		Correction Factor		ΔH @ (mm H ₂ O)	
Std. Vol.	Std. Flow	Std. Vol.	Std. Flow	Value	Variance	ΔH @	ΔH @
V _{w(Std)}	Q _{w(Std)}	V _{m(Std)}	V _{w(Std)}	Y	ΔY	ΔH @	ΔH @
161.58	11.54	160.28	11.5	1.0081	-0.0031	43.3	-3.811
151.33	15.13	150.63	15.1	1.0047	-0.0065	48.5	1.425
163.55	21.66	163.14	21.7	1.0025	-0.0087	47.4	0.319
169.36	27.46	166.10	27.5	1.0196	0.0084	47.6	0.487
172.18	33.33	168.63	33.3	1.0211	0.0099	48.7	1.580
				= Y Avg.		= ΔH @ Avg.	
				1.0112		47.1	

Note: For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is ± 0.02 .

Note: For ΔH₀, orifice pressure differential that equates to 0.0212m³/min at standard temperature and pressure, acceptable tolerance of individual values from the average is ± 0.2 inches (5.1mm) H₂O.

Pass/Fail Judgment : **Pass**

Calibrate By : *Dattaraj P.*

Approved By :

Date: 9 Feb 23

The instruments listed and described on this certificate have been calibrated against standards traceable to the National Institute of Standards and Technology (N.I.S.T.) and in reference to EPA Method 5, Section 10.3.1.

Nomenclature

- P_b - Barometric Pressure
- DGM - Dry Gas Meter
- K_1 - Constant based on standard temp and press
- Θ - Run time, in minutes
- P_m - ΔH (Meter Pressure, gauge)
- V_m - Volume collected by test meter, corrected for STP
- $Q_{m(std)}$ - Calculated flow rate of test meter
- K' - Critical orifice coefficient
- P_w - Measured pressure of reference meter
- t_w - Temperature measured in reference meter

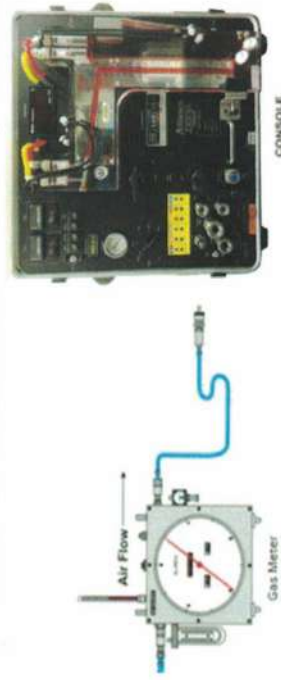
Equations

$$V_{w(std)} = Y * K_1 \frac{V_w * (P_{bar} + \frac{P_{m(g)}}{13.6})}{T_w}$$

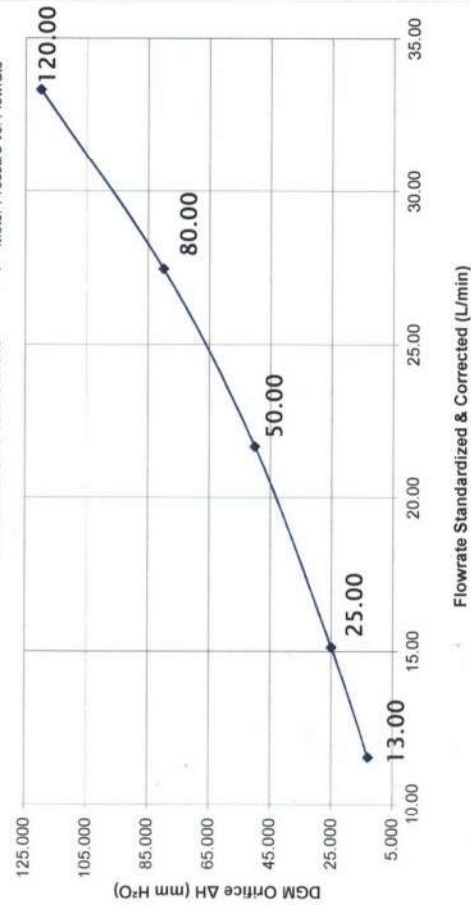
$$K_1 V_m (P_{bar} + \frac{\Delta H}{13.6}) = \frac{T_m}{T_w} \quad Y = \frac{V_{cr(std)}}{V_{m(std)}} \quad Q_{w(std)} = \frac{V_{w(std)}}{\Theta}$$

$$Metric \Delta H_0 = \frac{P_{m(g)} * 0.0011696 * (P_{bar} + \frac{P_{m(g)}}{13.6}) * (\frac{T_w * \Theta}{V_w * P_{bar}})^2}{T_m}$$

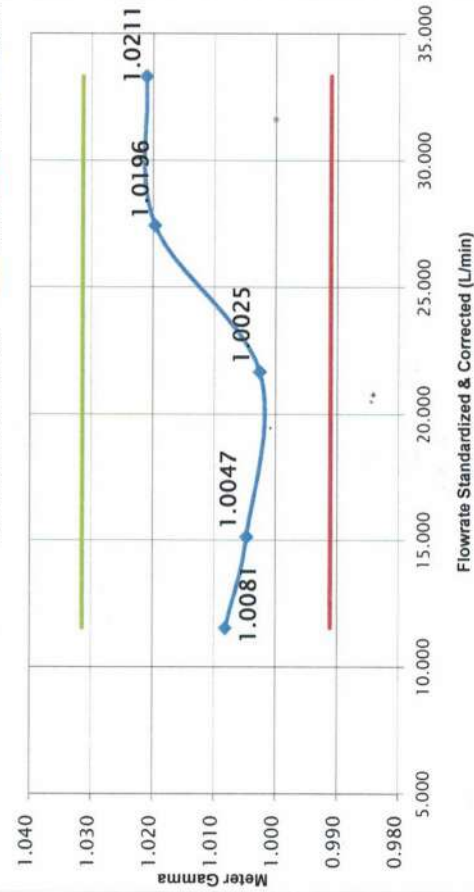
Calibration Train



Meter Pressure vs. Flowrate



Meter Gamma vs. Flowrate





Certificate of Calibration

Method 5 Console Sensor Calibration - Metric Units

Console Information

Model #: XC-572-V
Serial #: A1912535
Units: Metric

Calibration Conditions

Pbar (mm. Hg): 758.3
Humidity (%): 40
Tamb (°C): 25.6
Elevation (m): 1.8
Corr. Pbar (mm. Hg): 758.2

Reference Devices

TC Calibrator Model: CC-VTR-SH
Reference #: 091109269
Barometer Model: 736930
Reference #: EBARODIALSPE01
Pressure Model: 718 30G
Reference #: 9543013

Temperature Display Calibration Data

Reference Point ¹	Reference Temp.	Test Thermocouple Calibrations						Reference Point Status ²
		Aux	Stack	Probe	Oven	Filter	Exit	
#	°C	°C	°C	°C	°C	°C	°C	Pass/Fail
1	-18	-17	-17	-17	-17	-17	-17	PASS
2	38	38	38	38	38	37	37	PASS
3	93	93	94	94	94	93	93	PASS
4	149	149	150	150	150	149	149	PASS
5	260	259	259	260	260	259	259	PASS
6	371	371	372	372	371	371	372	PASS
7	482	482	482	483	483	482	482	PASS
8	593	593	594	594	593	593	593	PASS
9	816	815	816	816	815	815	815	PASS
10	1038	1037	1038	1038	1038	1038	1038	PASS
								PASS

Overall Audit Status

NIST Reference Thermocouple ID:

12702001

Ref Point	Theoretical Temp.	DGM Thermocouple Sensor Reading	ΔT_{abs} ⁴
#	°C	°C	°C
Ice Water			
1	0.2	0	0.07%
Ambient ³			
2	25.6	24	0.33%
Maximum ²			0.33%
Status			PASS

Internal temperature thermocouple is not audited to EPA standards, and should not be used as an official reference for ambient temperature.

Calibrate By :

Dattapan P.

Approved By:

[Signature]

Date: 9 Feb 23

Notes

¹ Suggested, minimum reference points are 10 (0, 100, 200, 300, 500, 700, 900, 1100, 1500, 1900 °F), can test for more.

² For valid test results, the maximum difference between temperature and reference readings should be less than ± 5.4 °F (± 3 °C), for all thermocouples except for the stack thermocouple which should be less than $\pm 1.5\%$ absolute temperature from the reference reading and the exit thermocouple which should be less than ± 2 °F (± 1 °C) from the reference reading (EPA Method 2, Section 6.3 and EPA Method 5, Sections 6.1.1.7-6.1.1.8)

³ Do not change this cell value, it is instead based on input from Cell H8 at the top of this sheet under "Calibration Conditions"

⁴ Absolute temperature difference and other formulas are calculated based on unit input from cell C8 at the top of this sheet under "Meter Console Information"

⁵ For valid test results, the maximum difference between console and reference barometric pressure readings should be less than ± 0.1 in. Hg (± 2.5 mm Hg), (EPA Method 5, Section 6.1.2)

⁶ For valid test results, the maximum difference between console and reference vacuum readings should be less than ± 0.5 in. Hg (± 12.5 mm Hg)

⁶ For valid test results, the maximum difference between console and reference vacuum readings should be less than ± 0.05 in. H₂O (± 1.25 mm H₂O), or 5% of full scale



Console Sensor Calibration Data Sheet

Console Information

Model #: XC-572-V
Serial #: A1912535
Units: Metric
Type:
"English"

Calibration Conditions

Pbar (mm. Hg): 758.3
Humidity (%): 40.0
Tamb (°C): 25.6
Corr. Pbar (mm. Hg): 758.2

Reference Devices

TC Simulator Model: CC-VTR-SH
Reference #: 091109269
Barometer Model: 736930
Reference #: EBARODIALSPE01
Digital Pressure Calibrator Model: 718 30G
Reference #: 3891001

Pressure Gauge / Manometer Calibration Data

Console Vacuum Calibration			
Reference Point	Reference Vacuum	Console Vacuum	Reference Point Status ⁶
#	in. Hg	in. Hg	Pass/Fail
1	-5.0	-5.0	PASS
2	-15.0	-15.0	PASS
3	-20.0	-20.0	PASS

Reference Point ¹	ΔH Manometer Calibration			Reference Point Status ²
	Reference mm H ₂ O	Positive (+) Pitot mm H ₂ O	Negative (-) Pitot mm H ₂ O	
#				Pass/Fail
1	-200.000	0.0	-200.0	PASS
2	-150.000	0.0	-150.0	PASS
3	-100.000	0.0	-100.0	PASS
4	-80.000	0.0	-80.0	PASS
5	-50.000	0.0	-50.0	PASS
6	0.000	0.0	0.0	PASS
7	50.000	50.0	0.0	PASS
8	80.000	80.0	0.0	PASS
9	100.000	100.0	0.0	PASS
10	150.000	150.0	0.0	PASS
11	200.000	200.0	0.0	PASS
ΔH Overall Audit Status				PASS

Reference Point ¹	ΔP Manometer Calibration			Reference Point Status ²
	Reference mm H ₂ O	Positive (+) Pitot mm H ₂ O	Negative (-) Pitot mm H ₂ O	
#				Pass/Fail
1	-200.000	0.0	-200.0	PASS
2	-150.000	0.0	-150.0	PASS
3	-100.000	0.0	-100.0	PASS
4	-80.000	0.0	-80.0	PASS
5	-50.000	0.0	-50.0	PASS
6	0.000	0.0	0.0	PASS
7	50.000	50.0	0.0	PASS
8	80.000	80.0	0.0	PASS
9	100.000	100.0	0.0	PASS
10	150.000	150.0	0.0	PASS
11	200.000	200.0	0.0	PASS
ΔP Overall Audit Status				PASS

Calibrate By:

Dattaraj P.

Approved By:

[Signature]

Date:

9 Feb 23

Notes

¹ Suggested, minimum reference points are 10 (0, 100, 200, 300, 500, 700, 900, 1100, 1500, 1900 °F), can test for more.

² For valid test results, the maximum difference between temperature and reference readings should be less than ±5.4 °F (±3 °C), for all thermocouples except for the stack thermocouple which should be less than ±1.5% absolute temperature from the reference reading and the exit thermocouple which should be less than ±2°F (±1 °C) from the reference

³ Do not change this cell value, it is instead based on input from Cell H8 at the top of this sheet under "Calibration Conditions"

⁴ Absolute temperature difference and other formulas are calculated based on unit input from cell C8 at the top of this sheet under "Meter Console Information"

⁵ For valid test results, the maximum difference between console and reference barometric pressure readings should be less than ±0.1 in. Hg (±2.5 mm Hg), (EPA Method 5, Section 6.1.2)

⁶ For valid test results, the maximum difference between console and reference vacuum readings should be less than ±0.5 in. Hg (±12.5 mm Hg)

⁷ For valid test results, the maximum difference between console and reference vacuum readings should be less than ±0.05 in. H₂O (±1.25 mm H₂O), or 5% of full scale

I certify that the above Thermocouple Sensors were calibrated in accordance with US EPA Methods 2 and 5, CFR 40 Part 60.



Console Sensor Audit QA Sheet

Meter Console Information (UUT)

Model #: XC-572-V
Serial #: A1912535
Units: Metric

Calibration Conditions

Pbar (mm. Hg): 758.3
Humidity (%): 40
Amb. Temp. (°C): 25.6
Altitude (m): 1.8
Corrected Pbar (mm. Hg): 758.2

Reference Devices

TC Simulator Model: CC-VTR-SH
Reference #: 91109269
Barometer Model: 369307
Reference #: EBARODIALSPE01
DP Calibrator Model: 718 30G
Reference #: 9543013

Audit Data

Reference Point	Reference Temp.	Thermocouple Probe Audit						Reference Point Status ¹
		Aux	Stack	Probe	Oven	Filter	Exit	
	°C	°C	°C	°C	°C	°C	°C	Pass/Fail
Boiling	100	100	100	100	101	100	101	PASS
Room	25.4	25	25	24	25	25	25	PASS
Ice Water	0.2	0	0	0	1	1	0	PASS

Console Vacuum Audit

Reference Point	Reference Vacuum	Console Vacuum	Reference Point Status ²
#	in. Hg	in. Hg	Pass/Fail
1	17.0	17.0	PASS

Calibrate By: Pattaraporn P.

Approved By: [Signature]

Date: 9 Feb 23

Notes

¹For valid test results, the maximum difference between test and reference readings should be less than 5.4 °F (3 °C), for all thermocouples except for the stack thermocouple which should be less than 1.5% absolute temperature from the reference reading and the exit thermocouple which should be less than 2°F (1 °C) from the reference reading (EPA Method 2, Section 6.3 and EPA Method 5, Sections 6.1.1.7-6.1.1.8)

²For valid test results, the maximum difference between console and reference barometric pressure readings should be less than 0.1 in. Hg (2.5 mm Hg), (EPA Method 5, Section 6.1.2)

³For valid test results, the maximum difference between console and reference vacuum readings should be less than 0.5 in. Hg (12.5 mm Hg)

I certify that the above Thermocouple, Barometric, and Vacuum Sensors were calibrated and audited in accordance with US EPA Methods, CFR 40 Part 60.



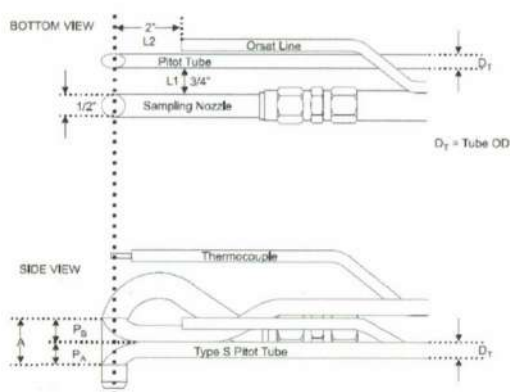
Sampling Probe and Pitot Validation

Samplig System Equipment Information

Probe Sheat	Apex 1 in. , 5 ft.
Probe Number	W1909261
Pitot tube Number	A8895
Pitot tube Type	S Type 3/8 Inc.
Validation method	Standard Probe 1 in. and 1/2 in. Sampling Nozzle

Valibration Conditions and Equipment

Digital Calipers	CD-15APX
Reference No.	A22070181
Digital Inclinator	BASELINE
Reference No.	FEI 12-1057
Temperatute	25.6 °C±3
Barometric Pressure	758.2 mm Hg



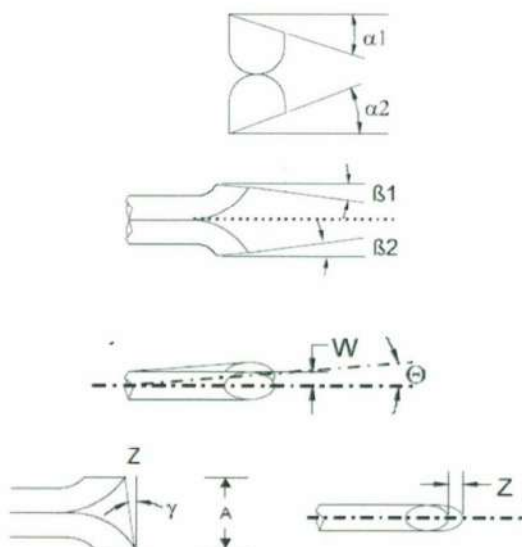
Sampling Probe Validation with Tune up

☒ Measure and Alinment with 1/2" Sampling Nozzle(12.7 mm)

Measured	Standard Range
$L_1 = 1.90$ cm.	(1.905 cm. or 3/4 in.)
$L_2 = 4.97$ cm.	(5.08 cm. or 2.0 in.)
$D_T = 0.953$ cm.	(3/8 in.)
$A = 2.19$ cm.	($2.1 D_T \leq A \leq 3D_T$)
$A/2D_T = 1.149$ cm.	($1.05 P_A / D_T \leq A \leq 1.5$)

Pitot Tube Validations and Engles measurement Result

☒ : Measure Result after Maintanance and Adjustable



P_B Size	Standard Range
$\alpha_1 = 1.40^\circ$	$\leq 10^\circ$
$\beta_1 = 0.90^\circ$	$\leq 5^\circ$
P_A Size	
$\alpha_2 = 1.40^\circ$	$\leq 10^\circ$
$\beta_2 = 0.30^\circ$	$\leq 5^\circ$

Engles measurement	Calculated Result	Standard Range
$W = -1.10^\circ$	-0.042 cm.	$W < 0.08$ cm (1/32 in.)
$Z = 0.22^\circ$	0.008 cm.	$Z < 0.032$ cm (1/8 in.)

Can be use 0.84 for $C_p(s)$ if the type of face-opening misafgnment show above with not affect the base line value of $C_p(s)$ Solong as standard range

Validation By:

Pattengum P.

Approved By:

h

Date:

9 Feb 23



Nozzle Validation

Samplig System Equipment Information

Console Model	XC-572-V
Console Number	A1912535
DGM Model	SK25EX
DGM Number	00006056

Validation Conditions

Digital Calipers	CD-15APX
Reference No	A22070181
Temperatute	25.6 °C±3
Barometric Pressure	758.2 mm Hg

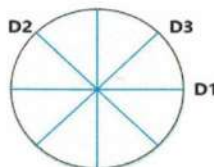
Validation Data					Results	
Nozzle ID	Nozzle Diameter				Different	(D ₁ + D ₂ + D ₃) / 3
Sizes		D ₁	D ₂	D ₃	ΔD	Davg
	mm	mm	mm	mm	mm	mm
NS-4	3.17	3.17	3.17	3.18	0.006	3.173
NS-6	4.77	4.76	4.76	4.76	0.000	4.760
NS-8	6.35	6.36	6.36	6.36	0.000	6.360
NS-10	7.92	7.91	7.92	7.92	0.006	7.917
NS-12	9.52	9.52	9.51	9.51	0.006	9.513
NS-14	11.09	11.09	11.09	11.09	0.000	11.090
NS-16	12.70	12.71	12.71	12.72	0.006	12.713

Where :

D₁, D₂, D₃ = There difference nozzle diamiters , mm ; diameter must be within 0.025 mm

Δ D = Maximum difference between any two diameters, must be ≤ 0.100 mm

D avg = (D₁ + D₂ + D₃) / 3



Validation By:

Pattangran P.

Approved By:

[Signature]

Date:

9 Feb 23